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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

Volume 90 — NEW YORK, MARCH 8, 1923 — Number 10

For Railway Engineers—and Others

ONCE a year there meets at Chicago a representative group of the engineers who are building and maintaining the railways of this country, there to discuss the problems of their work. This issue of *Engineering News-Record* is directed not alone to the men who meet at Chicago but to the large body of men of their type, for the entire group of such men many times outnumbers the few who can attend the A. R. E. A. convention. Future possibilities and past performances are both represented in the articles that follow. It is to be hoped that they will be read and appreciated not only by the engineers in railway work but by all the engineering profession, for while railway engineering is specialized many of its lessons are applicable to the whole field of engineering practice.

Southern Road Building

AROUSED by the success of North Carolina in developing at high speed an excellent state road system following its loan of $50,000,000 for construction, the other Carolina to the south and Tennessee at the west are conducting promising campaigns for large bond issues for public roads work. The amount contemplated in South Carolina is $60,000,000 and in Tennessee is $75,000,000. With a further issue of $15,000,000 by North Carolina and the $60,000,000 borrowed by Missouri this northern tier of southern states has in mind an expenditure of over a quarter of a billion dollars for highway construction. Evidently the "awakening of the South" to the importance of good roads and the inauguration of its states into the list of fast spending road-building states, are not to suffer in comparison with any similar activity of the North. There is something a little finer in this spirit which is urging these states to great highway expenditures than in the willingness of the states of the North to assume large debts for transportation facilities. While the northern states have built for traffic in hand these states of the South are borrowing money to develop a country and its road transport. None of the states named have had roads in the sense that they have existed in New York and New Jersey for a score of years. They are involving their credit to create out of their network of trails a system of modern highways. This is a bolder task than enlarging highway facilities for a traffic that already exists. The South in the next few years is likely to win the record of great mileages per annum of highway construction now held by the middle western states.

A Proper Rebuke

WHATEVER be the breach of the ambassadorial proprieties in George Harvey's speech last week on the British loan it was a useful reminder not only to the British people but to a whole continent of Europe which is too easily falling into the acceptance of the United States as the sole beneficiary of the war. So long as they believe over there—as most of them do now believe—that this country was a usurious money lender during the war and a demanding creditor today, thus long will be withheld those desirable friendly relations the world now needs and that desirable commercial comity which is necessary to a full development of foreign trade. The antagonism to the United States of an individual purchaser is not important nor is even group antagonism serious now when there are few with money enough to buy, but sooner or later Europe will begin to come back to a purchasing basis and then good feeling toward the United States may shift the balance toward a successful foreign business. Ambassador Harvey was a little brusque in reminding some distinguished Englishmen of the limits to which domestic politics led one of their equally distinguished fellows, but brusqueness has before this proved to be an admirable feature of American diplomacy. A few more such plain statements, a few fair but not boastful references to the vast volume of international charity originating here, all properly broadcast from Wales to Lithuania, may impress the Europeans that this country resents the rôle in which most European politicians would cast it, and better still may serve to disabuse the European people of some popular misconceptions of the United States.

Multiplying Railway Terminals

RAILWAY terminal planning in Chicago has reached a point of obvious conflict of prospective facilities. Independent projects for the reconstruction of certain stations include provision for accommodating the roads now using other stations. In other words, each of two or more projects proposes to make the other project unnecessary. Where railways own valuable property and have large investments in facilities for their own use it may not be easy to persuade them to become tenants of other stations, but careful study might show real economy in the sale of present property, or its utilization for revenue-producing purposes, with the consequent reduction in fixed charges and overhead expenses. Such a policy of co-operation and combination might be favored also in view of the large cost of reconstruction of all the stations. In any case it would be unfortunate to perpetuate three costly new stations practically side by side, which would be the result if all the projects were carried out. If the groups of railroads now occupying the present three stations whose reconstruction is proposed should be combined in one new station or partly distributed among existing stations, Chicago would have all its railways combined in not more than four great stations. To distribute passenger terminals in separate traffic centers is proper foresight, now that city congestion looms so large as a municipal problem. In a city so large as Chicago—or even in one the size of Cleveland—one station would be a monstrosity but there is a limit to the multiplication of terminals.

Charging for Garbage Collection

GARBAGE collection is one of the services that every city and town should render its householders. Preferably collections should be made by the municipalities but a well drawn and supervised contract service may be warranted under some local conditions. Unless a municipality is in a bad way financially the service should be free. Where cities are in dire financial straits (as many are in Ohio, under legislative restrictions on both taxation and bond issues) it may be wise to charge householders for garbage collection, in the hope that it will be temporary only. Bucyrus, Ohio, has recently passed an ordinance for municipal collection with a monthly charge of 50c. a house, payable quarterly in advance, and with a requirement that the householder must carry the garbage can to the street or alley. Here are two petty annoyances to the householder: Paying $1.50 four times a year, and carrying the can to the street. In addition, the city must do much bookkeeping and collecting, all of which would be obviated if the cost of the service were included in the general tax levy. With a condition and not a theory confronting Ohio cities the Bucyrus plan has justification. Presumably the citizens of Youngstown, Ohio, would pay a collection charge rather than have their garbage accumulate as it began to do on Feb. 1 because there were no longer funds to pay the contractor for collection and disposal. Both these cities show at least a will to do better for their people than large and wealthy San Francisco, where garbage is still collected by private scavengers.

Work Ahead

INSISTENT attention is once more directed to the serious problem of railway track. The third report on track stresses brings out much more sharply and clearly than the previous ones how dangerous a tax is placed on the rail. Stresses are reported than run far beyond 50,000 lb. per square inch, and even to 75,000. Such stresses are ample reason for the frequent failure of rails. So long as they continue to occur, track conditions will be abnormal and unsound, and the track problem—the problem of track safety and operating economy—will remain an unsolved, disturbing problem.

There is work ahead in dealing with this problem. It is one in which track builder and locomotive builder are jointly concerned, and only their joint study will bring results. Up to the present, each has gone his own way, one in developing the track, the other in developing the loads that are carried by this track. The time has come when this independent progress is no longer satisfactory; what it leads to may be read from the Track Stress committee's researches. The traditional system of railway organization is responsible for keeping the engineering and motive power men apart; it is time to see what can be done when the two departments work together instead of separately.

In another article in this issue the views of an experienced railway man on coming railway engineering needs are set forth. Among other things he declares that the development of railway motive power has followed a doubtful course, and that the ultimate cost of operation with the heavy, unbalanced engines of today is quite unknown. He calls for a working together of the engineers concerned with track and vehicles. Precisely this demand speaks from the figures revealed in the report of the Track Stress committee..

In a general way the dangerous condition of track resulting from bad locomotive counterbalance and other mechanical imperfections of the engine as a vehicle were set forth in the preceding report, the second report of the committee. The three years of investigation since that report fully confirm and reinforce its teachings in this respect. They go much farther, however, and by their figures on lateral stresses and curve actions they demonstrate that the lateral stresses existing on straight track as well as the vertical and lateral effects on curves increase the seriousness of the condition to an extreme degree.

In particular, the study of curve action makes the picture of track phenomena now complete in its broad outlines. The erratic action of railway vehicles on curves is disconcerting to those who hope for rational and safe track engineering; the vertical load effects are abnormally different from what calculation would indicate, and the lateral thrust and blows are quite alarming. But the significant part of the whole story is that these dangerous effects occur under some locomotives and not under others. With the same wheel loads, some locomotives are easy on the track, while others are a constant menace to the integrity of the track and the safety of trains that run over it. This is the condition that first of all calls for remedy.

It should be remembered that there is no field of construction in which engineers venture to stress material of even the highest quality to the extent that rails are stressed. Even in purely static service, and with metal whose strength is double that of rail steel, as in the cables of suspension bridges, the stresses do not exceed those which we tacitly accept in railway track service. Given a metal like that of rails, and service involving such concentrated pressures and such tremendous blows as are exerted by locomotives and cars, no sane engineer would think for a moment of designing or building on the basis of stresses between 50,000 and 75,000 lb. per square inch; and if, in a structure in service, he found such stresses existing he would immediately reduce the load or proceed promptly to strengthen his structure.

The fact is that railway engineers have been working for years to strengthen their track structure. Heavier rail has been laid, better track fastenings used, deep ballast put in—and yet the high stresses exist. Endless discussion also has been waged over rail quality. Every one concedes that better rail steel is needed, the dispute being over how it shall be improved; but even with perfect rail steel, the track problem will not approach a solution while stresses of the present magnitude are permitted. They must be reduced, and, as the track builder alone cannot reduce them, he must have the co-operation and help of the locomotive builder and motive power man.

Present railway track has reached a point of development where no marked increase in robustness or carrying capacity can be expected for a considerable time to come. The track, therefore, is one of the data on which the method and devices of railway operation must be based. Locomotive construction must be based on the available strength of the track, in other words. This is the fundamental view, we believe. It is not new, but it has been only a subconscious thought in the railway mind. With detailed facts on track stresses available, it should now become definitely conscious, and be made the controlling view in dealing with the joint problem of railway vehicles and track.

Still a Place for the Railway Engineer

BECAUSE of the recent decline in railway construction and expansion and the resulting limitation of the field of employment for railway engineers, there has been a tendency to become discouraged over the outlook for their future. This is but natural; yet such an attitude fails to take into account a number of counter influences, some of which are suggested by the interview with W. S. Kinnear, reported elsewhere in this issue.

In the early days of railway building the locating engineer was close to the heart of the enterprise and developed both the science and the art of his profession to a noteworthy degree. Then, during the period of unrestrained and all too often unscrupulous competition, came the day of the traffic man, who, in the role of "business getter," became an important figure in the transportation industry. With the coming of increased governmental supervision, with more restricted competition, and with uniform rates and regulations, came the need for increasing efficiency in the conduct of the transportation business, with increasing emphasis upon the work of those charged with operation. We are still living in this period, but, as indicated by Mr. Kinnear, there is need for a new attack by the engineer upon the railway problem; this time to readjust his transportation structure to the changed conditions under which it must now function, and to tackle anew some of the problems that many have looked upon as being quite settled and standardized.

Some railway engineers already have read the signs of the times and have applied themselves to their new responsibility. This, of course, has been most evident in the field of maintenance, which has continued under the charge of the engineer and which has been profoundly affected by modern operation. So harassing has this problem become that relief is being sought either in a reduction of the loads to be cared for or in new designs for the track structure that will decrease the heavy and continuing maintenance charges. Under these conditions maintenance work no longer can be regarded as a mere routine performance, for it has become a challenge to the ingenuity and resourcefulness of the engineer of the highest type.

In addition to more complicated requirements in the maintenance of way and structures, the emphasis on more efficient operation has been reflected in the work of the engineer by the vast amount of "additions and betterments," which have been undertaken to provide more ample and more economically operated facilities for handling increasing traffic. New freight yards, freight houses, engine terminals, yard extensions, double tracking, bridge renewals, shop construction, and revision of line and grade, all are in this class, and all these will demand increasing study on the part of the railway engineer who is to deserve his proper place in the railway scheme of things.

Be it noted, however, that in approaching these tasks there is need for a generous measure of the research spirit and for a scientific outlook that will regard them as engineering problems demanding analysis clear back to the fundamental principles involved, and the working out of solutions that will be based upon fact and reason rather than upon mere precedent or custom. The exchange of experiences between engineers engaged in similar work always is decidedly worth while, but its real value lies in its power to stimulate originality rather than in the opportunity it offers for substituting ready-made solutions for independent engineering thought. Standardization of practice likewise is valuable in many fields because of the economies that can be effected by uniform practice, but eternal vigilance is necessary lest excessive standardization become a drag upon progress and discourage independent thinking. In an industry in which so much of the engineering work has in recent years become largely a matter of standards and routine administration, there is grave danger of permitting the questionnaire to usurp the place of research and an over-developed respect for prevailing practice to stifle the exercise of original thought and engineering judgment. The problems that now beset the railway engineer and that will demand his attention in the days just ahead of us will not yield to such treatment.

Engineers for Railway Track Work

ALTHOUGH the supervision of modern track maintenance is requiring more and more of technical skill and knowledge, it is a strange fact that few railways or railway engineering departments offer much opportunity or encouragement for the young engineer desiring to make a specialty of maintenance-of-way or to acquire personal experience with the details of the work. This is not new statement, but the situation is called to attention anew by the article on another page reviewing engineering opinions on various phases of maintenance and showing how little recognition appears to be given to the practical and economic value of engineering knowledge in relation to track maintenance.

It is hardly necessary to say that a man may be a competent engineer of maintenance without having the ability to drive a spike straight or to surface a stretch of track. But of necessity he will have a better grasp of the higher duties of his department and a better understanding of the working conditions of his forces if he has had some experience in—and perhaps responsibility for—the routine and exceptional or emergency work on the track.

It appears to be general practice to train an engineer in railway service by making him a rodman or an axeman, then an instrument man and then up through successive stages in the engineering department, including perhaps both construction and maintenance work. During this course he will naturally pick up some knowledge of track work. But this is very different from personal experience and responsibility or a definite specializing in this class of work. It is true that some experiments in training young men in the track department have not proved successful. But in some cases the failure may be attributed to the fact that the railways have demanded too much in the way of hard work and have given too little in pay, promotion or promise of permanent employment.

Track design and maintenance need men of technical knowledge seasoned with practical experience. The young engineer is well grounded in the former, yet there is at least a passive resistance to the man who may be attracted to this particular field and who desires to familiarize himself with it or to make it his specialty, as another man might specialize in bridge work. It seems certain that appreciable economic results can be realized through a policy of developing engineers specially skilled in the design, construction and maintenance of track.

The Railroad Engineer and the Needs of Tomorrow

Survey of the Problems that Lie in the Foreground of Railroad Development and a Plea for a Policy that Will Help the Engineer to Solve Them

An Interview with
W. S. KINNEAR
Consulting Engineer, New York

MINDFUL of the confusion visited upon the three friends who sought to comfort Job in his afflictions, the prudent might well shrink just at this time from any temptation to advise or condole with the railroad engineer. He has been having a hard time of it. Day after day he has been facing the ever present and ever more exacting task of keeping his property abreast of the demands that have been made upon it, and all this with resources that have been meager indeed. He has risen splendidly to his heavy responsibilities—more splendidly than ever he will have credit for—and only now he is beginning to breathe more easily and to feel a relaxation of the pressure that has borne upon him so heavily during the last few years. So it would seem to be courting a just and indignant wrath for any one, however friendly and well intentioned, to offer him at this particular juncture a word of counsel and admonition concerning the work that lies just ahead of him.

Yet some bold spirit must brave the chance, for there is great need that the engineering staffs of our railroads and those from whom they must derive their inspiration and authority should readjust their viewpoints just as quickly as may be practicable to suit a radical change in their economic objective. For the last few years they have been compelled to work on a close-up basis. Of necessity they have lived from hand to mouth, each day bringing its own measure of harassment pressing insistently for relief. Often the rule of sheer and desperate expediency has prevailed. Unremitting and intensive in his application to detail, putting forth every energy to "hold what he had," the railroad engineer for several years has had his eyes fixed upon the task immediately in front of him.

But with the relaxing of this pressure he now must turn to meet a new demand, none the less exacting, none the less urgent, yet so different in scope and character as to require a material readjustment of mental focus. The new problems demand long vision rather than close application; a broad view, rather than intense scrutiny. He must, in short, take stock of the problems that lie in the foreground of railroad engineering development, recognize them, analyze them, evaluate them in terms of their significance to the transportation needs of the nation, and then tackle them with a vision and an energy that is just as necessary today as it was in the pioneer days of railroad building. He must turn on the one hand to the solution of new problems and on the other, to a constructive and forward-looking re-valuation of old ones, so that the needs of tomorrow may be met on a basis of ultimate economy, rather than of desperate expediency.

Many engineers who have been looking ahead doubtless have well-conceived opinions as to the solution of these problems, and Mr. Kinnear's views are here set forth, not in a spirit of dogmatic pronouncement but rather in one of helpful suggestion, reminder, and stimulus. Some of the matters here dealt with are beyond the scope and authority of the engineer; still they are not hopelessly beyond his influence, and certainly they are not without an important bearing upon the net result of his efforts.

Organization—Broadest, perhaps, and most fundamental of the problems that confront many engineering departments is that of their plan of organization. The net worth of the service that can be rendered to the community by any corps of engineers, however skillful and accomplished, is profoundly affected by the scheme of organization under which they must work. In assigning to the engineer a place in the machinery of organization, it must be remembered, therefore, that the chief engineer of a railroad and his assistants must assume responsibility for the intelligent investment of great volumes of capital and for the conservation of huge property investments. It is recognized, to be sure, that the function of a railroad is to provide transportation and not to set up an exercise in engineering. Yet it should never be forgotten that next in importance to a skilled and loyal personnel, the backbone of the transportation machine is the physical property of which it is composed. And however loyal the personnel and however resourceful may be those charged with operation, it is obvious that so huge and so intricate a property as a modern railroad cannot be unskillfully built or maintained without far-reaching, incessant and irretrievable waste—waste that will sap both the substance and the revenues of the railroad itself, of its individual stockholders and of the community at large. And it must be obvious also that the men charged with responsibility for this phase of the transportation industry cannot be regarded as hired hands subject to the beck and call of an operating executive if they are to do justice to the peculiar and inevitable responsibilities that rest upon them.

From this it appears that continued study and effort should be applied to obtaining for the engineering staffs of our railroads a measure of authority and recognition comparable with their grave and basic responsibilities. It is not too much, for example, to ask that the chief engineer of a railroad be given the standing of an elected officer of the company and the opportunity to participate in the deliberations of its supreme managing body; and leaping to the other end of the scale, it is not too much to ask that division engineers be made co-ordinate in standing and authority with the division officials responsible for operation. Their tasks are of co-ordinate importance. The engineer is—or should be—the custodian of the fixed assets of the company; the operating official is charged with the wise administration of its working capital. These men are partners in the conservation of the resources and earning capacity of the property, and from each of them should be expected original and progressive thinking with regard to his own department's problems.

Such a partnership encouraged by the general management can be of immense benefit not only to the

property itself because of the encouragement that would be given to the creative instincts of its engineering staff, but also, viewed from another aspect, to the property and the individual engineer jointly. Such a partnership between operating and engineering officials is bound to develop in the operating man a keener appreciation of the problems and the viewpoint of the engineer, and in the engineer the broader understanding of the whole transportation problem that will better fit him for advancement in the railroad service. Feeling a co-ordinate responsibility with the operating officials for the production of safe, adequate, and efficient transportation, he is much more likely to become imbued with the spirit and to develop the outlook that make the all-round transportation man, of far greater value to himself and to his road than if he be rated simply as one gear in a machine that is managed exclusively by an operating executive.

While on the question of organization it may be well to consider also a policy of systematic inspection trips by railroad engineers over other properties. To obtain the maximum of benefit, such trips should be taken by division operating and engineer officials together, so that in sizing up the other man's methods they may have an opportunity to exchange ideas with regard to their respective fields. Aside from the technical knowledge and stimulus that result from such an experience, this practice operates also to develop a greater community of interest between the engineer and the operating officer; that is to say, rather than looking at transportation problems from an engineering viewpoint as against an operating viewpoint or vice versa, they are led to regard them from the viewpoint of "our road" as against the "other fellow's road." Such association, therefore, systematically carried out and intelligently administered should, in time, make for a higher morale in both branches of the service and an increased tendency to view home problems more from the standpoint of the railroad and its interest than from that of a certain department or special service.

While it may be that on some railroads all this is an old story, the fact remains that on too many roads that ought to know better there is a tendency toward self-sufficiency and narrowness of outlook, first, with regard to each of the individual services or departments, and, second, with regard to the road itself. The natural and inevitable outcome of this tendency when left unchecked is to promote an inbreeding which may be depended upon eventually to make for the injury of the property. Although in the engineering service such a condition is considerably remedied by the collaboration of individual engineers on the committees of the various engineering and railroad societies—and the technical benefits derived from these are not to be undervalued—the broader purpose cannot be thus attained because of the lack of participation by the co-ordinate operating departments of the transportation service.

Yards and Terminals—Although few railroad engineers are not conversant with the generally accepted principles of yard design—the necessity for keeping cars in motion always in one direction, the avoidance of unnecessary storage and delay, and the other basic principles—there still is room for improvement in their application. Yards and terminals are looked upon today as being the factors that limit the capacity of a railroad, and with the increasing expansion of traffic it is but reasonable to expect that the engineers on each division must study everlastingly the daily experience of the operating department in order to provide against the day when new and improved yards may be demanded.

Each divisional or terminal yard is, of course, a problem in itself, subject to local topography and local operating conditions. An appropriate design for a new yard or a betterment of an existing yard cannot, therefore, be based upon an indiscriminate application of general and standardized principles supplemented by a hurried survey and a superficial study in the face of stern and imminent necessity. Sound engineering and sound railroading alike demand that facilities of this sort grow out of accumulated observation, analysis and reflection by the engineer over a long period, coupled with a close and continuous association with the division operating official. Every snarl that jams a yard, every traffic crisis that crowds its capacity is replete with lessons to be noted on the spot, interpreted by the operating officer and digested by the engineer, against the day that he may be given the opportunity and the resources to carry out the improvement.

Although in the design of new yards much thoughtful study is devoted to securing an ideal plant, these observations bear particularly upon the period just ahead of us when we are bound to see more and more a demand for thoroughgoing revision of existing yards, which in many cases are frightfully complicated and congested as a result of patching a little here and fitting a little there, until operation has become very expensive and the entire transportation process has been slowed down. In the design of new yards and terminals and in the modernizing of existing facilities, there will be ample scope during the next ten or fifteen years for the best engineering and operating skill that can be made available, and for the sort of partnership between engineering and operating officials that has been outlined in another paragraph.

Scope will be offered also for considerable railroad statesmanship with respect to terminals at the more important centers, for it is scarcely to be doubted that, wherever possible, joint facilities will be demanded in the interest of more effective service to the transportation-buying public. The policy by which each individual railroad has its own independent terminal at such centers, thereby duplicating needlessly many costly facilities, may have been permissible and necessary in the early days of railroad development, but it is clear that we have passed that stage and that railroad managements must inspire their engineers to attack the terminal problem from a new angle; that of determining just how far joint facilities can be developed for more effective service to all. It is time to stop and ask ourselves whether we are not wasting our substance in working out costly and duplicate schemes in an effort to win for each property an all too questionable advantage over the others.

Another terminal problem that will demand more and more thought of the railroad engineer is that of collection and delivery of less-than-carload freight. An increasing number of those who have studied this question thoroughly lean to the opinion that such a service based upon the use of motor trucks or similar equipment might well be undertaken by the railroads with advantage to themselves and to the communities they serve. So far this subject has been chiefly in the hands

of general executives as constituting a question of policy, but before any plan can be carried into consummation, even upon an experimental scale, the engineer will be called upon to work out the details upon which will depend the efficient operation of the plant.

One special case of this general problem is that of motor handling of interchange traffic between the terminals of various railroads entering the large city, and another is the use of motor-driven cars for passenger operation over branch and feeder lines. It is not impossible that this experiment now under way in the passenger service may lead into a similar tryout for the handling of freight, using motor vehicles either on highways or on existing branch-line track. It would be just as well, therefore, for the engineer to commence now a study of these problems so that when he is called upon he may be able to bring to their solution a seasoned judgment, and avert the need for hasty contrivance, always so likely to result in a makeshift.

Closely related to the terminal problem is that of the through traffic that should be routed to avoid terminals and their attendant congestion—that should be kept out of terminals rather than worried through them. Belt lines for such traffic have already been provided at some of the larger centers, but there are many more that are worthy of study now. It is not too much to ask at the very least that the several roads entering each of the chief railroad centers of the country should get together now, agree upon the principles involved, and work out tentative plans for the provision of bypass lines around those centers, so that when the opportune moment for final decision has arrived the diverse interests all will have been reconciled, complicating physical factors will have been studied, and the plan will represent that mature judgment which alone can insure a minimum investment of capital for a maximum return in efficiency of operation and convenience to the shipping community. Here, again, is involved the cardinal principle that must govern the major portion of the terminal improvement work to be done hereafter; i.e., co-operation of interested carriers in joint efforts for solution of their common problems.

Track Structure—A committee of the American Railway Engineering Association is now engaged in studying designs for a possible 150-lb. rail. This is but symptomatic of the continually increasing weight of rail and track structure that has been required to keep pace with heavier and heavier wheel loads. It is not necessary to recount here the story of the "tonnage train" and the spread of the policy that we must have heavier and heavier motive power to draw heavier and heavier trains. Promulgated by Hill in the Northwest, this policy has become firmly established in the minds of transportation officials, and for years past the railroad engineer has been hard put to provide a foundation structure that would be equal to its demands. This process has been carried on so consistently that there is grave doubt today as to whether any one actually knows the cost of producing and conducting transportation, that is to say, the true cost, which would take into account in addition to the ordinary operating costs a proper share of the investment that has been made in way and structure, ordinarily considered as additions and betterments.

If we are irretrievably committed to the policy of heavier and heavier trains and units, if maintenance costs continue to grow as they have been growing, if rail failures continue to call for increasingly heavy sections, if ballast is to grow continually heavier and heavier, it is time for the railroad engineer to make sure that we should not turn to a new and altogether different design for track. In the present standard designs the heavier rail is needed as a girder to effect a better distribution of the load on the ballast, which, in turn, is designed to effect a better distribution to the subgrade. Is it not worthwhile, then, to overhaul this whole theory and to make sure that on the roads of heavier traffic we are not ready for a permanent foundation, probably of concrete, using short ties embedded therein to serve as cushions for the rail? Perhaps some other design entirely may be the answer, but it is becoming evident that if we must carry the continually increasing loads, we sooner or later will be forced beyond the question of heavier rails and thicker ballast to consider radical changes in the design of the entire track structure. The minds of maintenance engineers all over the country are agitated as to what we are going to do to hold our track, and this is one of the big questions that looms in the near future. It is time to ask ourselves whether we have not gone too far in the direction of heavy train loads, for it stands to reason that if we cannot afford to pay for a track that will stand up under these loads without excessive maintenance we have gone too far in increasing the loads.

Train Loading—This opens up, then, an entirely new question, one which properly comes within the purview of the operating department, but which nevertheless has a profound influence upon the work of the engineer. Some railroad executive with the requisite courage and capacity should tackle this whole question of train loads. The situation calls for a resurvey in the light of present conditions to determine whether the ultimate transportation economies effected by the most powerful locomotives we can build, hauling the heaviest trains that they can move, could not in many cases be equaled or exceeded by the savings that would result from the operation of lighter trains at higher speeds, involving less maintenance of track, less wear and tear on equipment, less loss of running time for high-priced motive power, fewer delays from equipment and engine failures, less overtime for road crews because of these and other incidental delays, and all the other benefits that would accrue from such operation. This, be it noted, merely poses a question, and does not pretend to state a fact; neither does it assert that what may be the fact in one case would be true in general. It indicates simply that in the minds of many the answer to the question is not so clear as it may appear to some, and suggests that a policy which might be sound in one region of the country for a certain type of traffic may not be the policy that should dominate the railroad systems of the country. The whole question needs to be ventilated and when the day of ventilation arrives the engineer should be a party to the process; and his judgment as the conservator of the railroad property value should be given due weight with that of the operating and motive power official who is primarily concerned with day-to-day operating results.

This consideration brings us back once more to the old question concerning the ultimate traffic capacity of a given railroad. Much of the double tracking, the three tracking, and the four tracking of our lines has

grown up piecemeal as a result of a demand for local relief, which often has been followed by a series of more-or-less haphazard extensions rather than by any systematic and planned analysis of traffic requirements. Here, too, is an opportunity for organized study which should involve the civil engineer as well as the signal engineer and the operating official. Closely related to it is the problem of automatic train control which now has been brought sharply into the foreground by the action of the Interstate Commerce Commission and which will engage the attention of railroad engineers and operating officials until some answer has been found.

Water Supply—Another problem that has engaged the attention of some of the larger systems, and that in the course of time probably will become more acute rather than less is that of an adequate and satisfactory water supply to meet the increasingly exacting demand of heavy and costly motive power. Development of water sources and of necessary processes for its treatment must be systematically studied in the interest of economy as to the cost per gallon supplied, and of decreased maintenance expenses and loss of time in service for locomotive boilers, which have been set down by one authority as a very weak link in the transportation chain.

Electric Traction—The place of electric traction in the transportation scheme will continue to demand the best thought of railroad engineers and executives for a long time to come. It has been demonstrated that where special conditions prevail, where large sources of power are at hand, where mountain grades of considerable length must be overcome and where congested traffic and terminal conditions govern operation, the use of electric motive power will effect economies and solve operating problems beyond the capacity of the steam locomotive. Yet, in the present state of the art there is little ground to hope for a sweeping transformation in this respect. In general discussion of the subject, it is often forgotten that the practical problem is not whether electric service is better than steam; the question to be answered by the transportation man is: Is electric service sufficiently better to justify the scrapping of equipment already in existence, or, if the project is to be tackled gradually, are the savings to be realized from electric operation on one division sufficient to compensate for a loss of flexibility involved in having that division organized with regard to motive power along entirely different lines from the others? It may turn out that electric operation may make possible the handling of lighter trains at higher speeds and enable us to pass over our lines an even greater volume than at present, at equal or less cost when all factors are considered. It is possible, therefore, that this development may have a far-reaching influence on several of the questions that have been discussed, but this, too, is merely a statement of a problem to be worked out by the railroad engineers of the country.

In many other respects the forward-looking railroad engineer will find opportunity to effect increased economies in operation. Some of these have to do with the thoroughness of maintenance work. Track that is out of line and grade not only subjects itself to rapid destruction, but involves also considerable increase in the cost of moving trains over it. A collateral phase of this matter concerns itself with the increasing use of mechanical devices to save labor on maintenance work. Another contemplates the installation of appliances for operating switches at a distance in order to expedite the movement of trains at passing track. These are but typical of many opportunities in almost every field of railroad engineering, which for some years to come will challenge the best skill that can be brought to bear upon them.

It will be obvious to all that many, if not all, of the suggestions here advanced deal with matters in which the engineer will be powerless without the encouragement and the resources that can be given to him only by sympathetic managements and executives; but if the executives are to rise to the responsibilities that lie ahead of them and are to satisfy the American people that they are willing and able to grapple with their transportation problems, they must call increasingly upon the skill, the training, and the constructive instincts of the men who make up their engineering staffs. Whether it be justified or not —and in most cases we all know that it is not—the opinion prevails with a large section of the American people that American railroad managements today have become hidebound, that they have settled down into a routine day-to-day occupation, that the chief executives too often are mere clerks or impotent figureheads, and that there is lacking the vision to see, the genius to grasp, and the energy to attack the essentials of our transportation problems. With this state of mind so prevalent and with the problems daily becoming more insistent, it is worth the while of railroad executives to ask themselves whether they are making the most effective use of the engineering skill that is at their disposal.

Cost of Remedying Deficient Sewers

HAPHAZARD sewer construction with little regard for the future development of the community served leads eventually to conditions summarized as follows by W. E. Stanley, assistant engineer, in a paper presented recently to the Iowa Engineering Society: (1) Frequent surcharge; (2) inability to make extensions; (3) difficult house connections; (4) high cost of new areas a considerable distance away from available outlets; (5) undue increase in stream pollution; (6) intercepting sewers difficult to build.

ESTIMATED COST OF PRESENT CONSTRUCTION REQUIRED TO REMEDY VARIOUS SEWER SYSTEMS

City	Est. Pop., 1922	Comprehensive Sewerage Planned for Year	Comprehensive Sewerage Planned for Est. Pop.	Estimated Cost of Present Construction Required Total	Estimated Cost of Present Construction Required Per Capita
Streator, Ill.	15,500	1960	30,000	$725,660	$46.80
Portsmouth, Ohio	40,000	1970	85,000	383,000	9.60*
Washington Court House, Ohio	8,200	1970	15,000	195,000	23.80*
Henderson, Ky.	12,300	1960	25,000	326,000	26.50
Weston, W. Va	6,000	1970	18,500	154,000	25.70*
Rhinelander, Wis.	7,300	1960	20,000	140,800	19.30
Totals	89,300	....	193,500	$1,924,460	$21.60 av.

* Includes plant for partial treatment of sewage.

The first consideration in meeting such conditions is an extensive and thorough engineering investigation and the making of a comprehensive plan which will utilize the present sewers to the best advantage and provide relief sewers for critical areas for 40 to 45 years in the future.

Mr. Stanley gave the estimated average per capita costs of such extensions for six cities as $21.60, ranging from $9.60 to $46.80, as shown in more detail in the accompanying table.

Grade Reduction and Widening on Illinois Central RR.

Novel Feature Is Use of Dragline Excavator in Widening Cuts—Contractor's Trains Handled on Busy Main Line

IN GRADE REDUCTION and roadbed widening for three and four tracks on the Illinois Central R.R. from North Junction to Monee and Matteson, Ill., a distance of about twelve miles, special features of the work were the use of a dragline excavator in place of a steam shovel for the long cut through the Monee hill and the adoption of construction methods which avoided interruption to heavy main-line traffic, even with all excavated material hauled over the main line. This is said to be the first case in which a dragline machine has been used for widening cuts on an operated line. A

FIG. 1—DRAGLINE EXCAVATOR WIDENING CUT

general view of the excavator at work on the large cut is shown in Fig. 1. An incidental but important item of the work was the moving of two grain elevators across the main tracks.

The improvement work now in progress on the 54-mile division between Chicago and Kankakee provides for a maximum grade of 0.3 per cent, but at Monee there was a summit or hump with a northbound grade of 0.425 per cent rising from a level stretch and then descending at 0.44 per cent. This was the most serious obstacle to traffic and occasionally it was necessary to split a heavy northbound train in order to handle it over the grade. In the revised profile not only is the summit eliminated but also the entire northbound ascending grade. From the profile, Fig. 2, it will be seen that the new line continues on the level for some distance and then has a descending grade of 0.2 per cent followed by 0.3 per cent, the latter running out to the old subgrade elevation.

It will be seen also that this change in grades involves heavy excavation, the main cut being about 9,000 ft. in length with an average depth of 20 ft. and a maximum depth of about 30 ft. Beyond this was another cut of about 4,400 ft. in length and 30 ft. maximum depth. A storage reservoir for railway water supply, in the sag between these two cuts, was drained to another reservoir further south and its site was crossed by a fill. The total amount of excavation will be about 1,000,000 cu.yd., consisting mainly of stiff blue clay having a few sand pockets but very little water.

Since the subgrade had to be widened to about 100 ft. to provide for additional tracks, advantage was taken of this feature to facilitate construction work and keep the work clear of traffic. The successive construction steps are shown in Fig. 3, from which it will be seen that the new cut has a bottom width of nearly 100 ft. to accommodate four main tracks and a passing track. At the south end of the track there will be three main tracks. The first operation at the long cut was to excavate a double-track cut along the east side of the roadbed, with the bottom conforming to the new profile and having a width of 32 ft. Two main tracks were laid in this cut, the rail head keeping close behind the excavation, as shown in Fig. 4. As soon as this first double track cut was finished the track connections were made and new tracks put in service without delay to traffic.

Excavation Procedure—This first cut was made by the dragline excavator working northward. The second step was with the excavator returning south on the west side of the right-of-way and making a cut of about 10 ft. deep as a widening of the old roadbed for a distance of about 3,000 ft. The third and final cut was made with the excavator working north again, traveling along the old roadbed and widening its first cut to the full 100 ft. width of the new subgrade for about 3,000 ft. Beyond this a modified method was adopted owing to the lateness of the season and the expectation of bad weather. Instead of making cut No. 3 its full width, a widening of 25 ft. was made first to prevent the possibility of material sliding onto the new main tracks in cut No. 1. This is shown by the line *A-B* in Fig. 3. When cut No. 1 had been widened in this way, the excavator moved south 3,000 ft. and then again worked north to complete cut No. 3 to its full width.

The use of a dragline excavator was adopted on account of the depth of cut, since with depths of 20 to 30 ft. steam shovel work would have necessitated making seven successive cuts, each wide enough for a dump-car track beside the shovel track. The dragline machine was operated on the surface and took out the cut to its full depth at one move. It loaded the material into cars on the old northbound track alongside the cut, this track being given up to the contractor and a new temporary second main track being laid on the west side of the old roadbed.

FIG. 2—PROFILE OF GRADE REDUCTION AT MONEE, ILL.

In Fig. 4 the machine is shown making the first cut, in which the two temporary main tracks are being laid. At the left is the surface track for the contractor's trains (being the old northbound track) and beyond this is the double-track main line. In Fig. 1, the machine is making the third cut of about 60 ft. bottom width, widening the first cut (at the right) to full subgrade width. In this novel method of widening an existing railway cut the contractor used a Bucyrus dragline excavator with 100-ft. boom and 5-yd. Page bucket, as shown in Figs. 1 and 5. This machine, weighing about 145 tons, moved on rollers on stringers and blocking. To haul itself back from the work it was revolved to put the boom forward and the bucket was lowered so as to dig into the ground and form an anchor. Then by hauling in on the bucket cable or dragline the machine was moved forward to the new position.

ates ten trains of fifteen cars each in this service, and notwithstanding the heavy main-line traffic, averaging about thirty passenger trains and sixty to seventy freight trains daily, the dragline excavator moves about 4,500 cu.yd. per twenty hours, working two 10-hour shifts. Its monthly performance ranges from 70,000 to 96,000 cu.yd. It can load a train of fifteen dump cars (averaging 12 cu.yd. per car) in twenty-five minutes.

On the long cut two steam shovels were operated before the dragline excavator was installed. These machines, with 2½-yd. dippers, started opposite ends of a cut 12 ft. deep along the east side of the right of way, this depth enabling them to load cars on a surface track. After the dragline machine had been put at work in the larger cut, one of the steam shovels was used for the widening of the smaller cut, since the width of right-of-way at this point did not admit of using the dragline

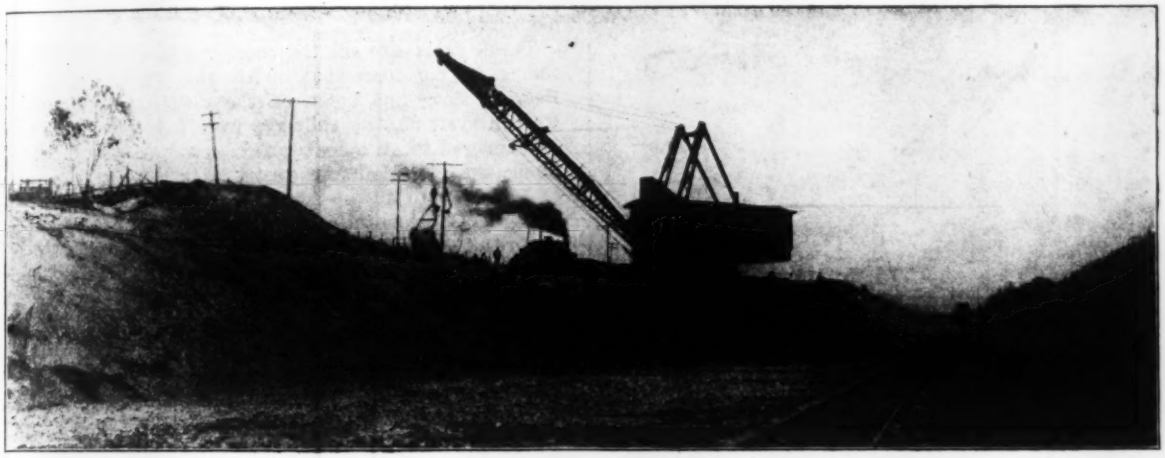

FIG. 4—EXCAVATOR MAKING FIRST CUT FOR GRADE REDUCTION

New double-track main line was laid in cut so as to be ready as soon as excavation was finished and track connections made. With traffic turned onto the new tracks the cut was widened for four tracks. Contractor's track at edge of cut, with old double-track main line beyond. Public street at right of cut.

Trains of fifteen air-operated dump cars of 12- and 16-yd. capacity are handled by the contractor's locomotives, but are in charge of the railway company's conductors since the trains are moved on main tracks. These dump-car trains enter the main line at an interlocking plant about one mile north of Monee and are operated as extras under orders from the train dispatcher. All loaded trains move north and with the engine at the rear end. Most of them have a haul of about six miles to Matteson, where the material is used for a fill in track elevation work which eliminates two railway grade crossings. About 25 per cent of the trains, however, have a haul of some twelve miles to Homewood, where the material is placed as filling for the new Markham freight yard. The contractor operates ten trains of fifteen cars each in this service, and notwithstanding the heavy main-line traffic, averaging about thirty passenger trains and sixty to seventy freight trains daily, the dragline excavator moves about 4,500 cu.yd. per twenty hours, working two 10-hour shifts. Its monthly performance ranges from 70,000 to 96,000 cu.yd. It can load a train of fifteen dump cars (averaging 12 cu.yd. per car) in twenty-five minutes.

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Auxiliary Works—Four steel girder highway bridges and one steel footbridge will be built across the cut at Monee. Steel signal bridges one mile apart will span the tracks and carry electric-lamp signals, no semaphores being used. Just south of Monee where the four-track line is reduced to three tracks, an interlocking plant is being installed at a cost of about $20,000. Since part of the edge of the new cut is along the side of a village street and main highway the street is protected by a fence

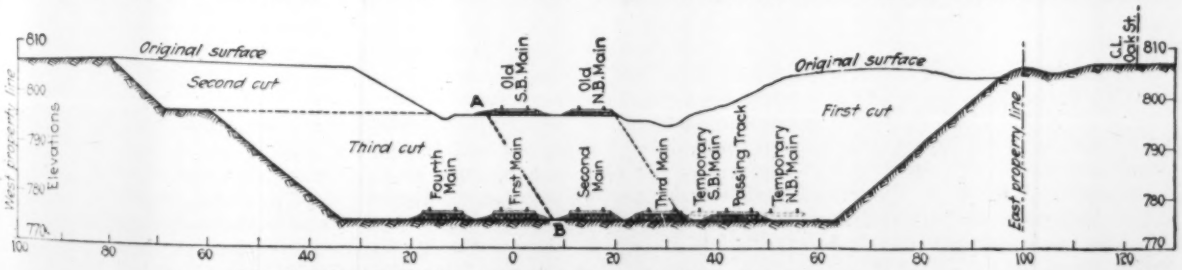


FIG. 3—CROSS-SECTION OF FOUR-TRACK CUT ON GRADE REDUCTION

consisting of tall concrete posts carrying low concrete slabs or panels surmounted by wire fencing. Where the track elevation near Matteson intersects a public road, a new concrete road will be built along the right of way for about ¾-mile, thus avoiding the construction of a subway. Subways with concrete abutments and bents and concrete slab decks will cross two railways. There is a small interchange yard at the crossing of the Elgin, Joliet & Eastern Ry. and an incline track connection from the new elevated tracks to the low-level intersecting tracks of the Michigan Central R.R. At Matteson there will be a new station and yard for the suburban trains, this point being the southern terminal of the Chicago suburban service (see *Engineering News-Record*, Nov. 16, 1922, p. 841). All tracks are laid with 90-lb. rails.

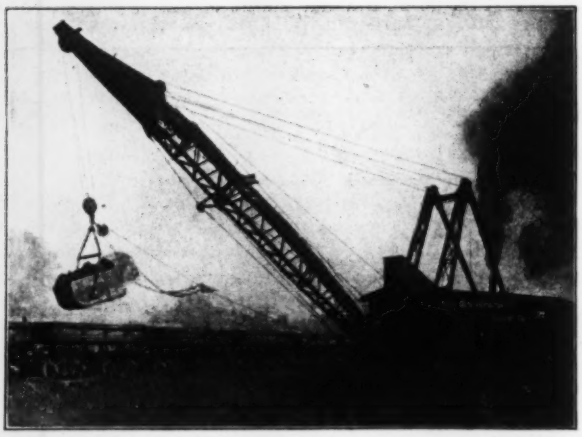


FIG. 5—EXCAVATOR WITH 5-YD. BUCKET LOADING CARS

Moving Elevators—Moving three buildings across this busy double-track main line was carried out successfully. The one-story frame station at Monee was moved across from the east side and turned around so as to face east. This move was accomplished in about twenty minutes, traffic not being blocked at all. The other two structures were 60,000- and 65,000-bushel grain elevators of frame construction, weighing approximately sixty tons each. The first elevator, in 32 minutes, was moved 150 ft. east across the tracks, and was then turned around and moved north 2,200 ft. The other in 1 hr. 54 minutes was moved 150 ft. across the tracks and then 500 ft. north. Both elevators were landed on new foundations at the top of the cut, with a high retaining wall forming the support along the track side. They were then united to form one structure.

Engineers and Contractors—The grading and tracklaying on this 12-mile improvement was let to the Walsh Construction Co., Davenport, Iowa, but owing to labor shortage the railway has done much of the tracklaying with its own extra-gang forces. W. A. Durkin was superintendent for the contractor. The buildings, including brick interlocking tower at Monee, were let to Joseph E. Nelson & Sons, Chicago, who sublet the moving of buildings to W. H. Brown & Co., Chicago.

All the work was planned and carried out under the direction of F. L. Thompson, chief engineer of the Illinois Central R.R.; F. W. Armistead, assistant engineer; T. H. Robertson, assistant engineer in charge, and G. C. Harris, resident engineer. It is expected to have the work completed in May, 1923.

Survey of Railway Conditions in Continental Europe

Slow Recovery from War Due Largely to Political Exploitation—Hope Lies in Return of Trained Technical Control

This is the first of three articles on the European railway situation by the London correspondent of ENGINEERING NEWS-RECORD.

THE foreign observer, investigating railway traffic conditions in Europe, is struck first by the fact that, with very few exceptions, the systems seem to have made no appreciable improvements since the close of hostilities. The service generally throughout Europe is well below pre-war standard, the rolling stock is depreciated, the fuel, especially in France, is shocking, and interference with travelers has been multiplied a hundred-fold. The freight traffic arrangements are primitive.

These facts are all the more remarkable when one comes to consider that, with the exception of the Belgian lines and some of the northern and eastern French systems, the railways were not interfered with or damaged to an extent which would account for their inefficient operation four years after the armistice. In endeavoring to dig up some reason for a very apparent laxity in Continental railway operation, if one questions any responsible railway executive the invariable answer is, *"c'est la guerre."* One accepts this in principle, but it is in getting down to "brass tacks" that one finds difficulty in accounting for systems whose efficiency has so obviously deteriorated.

Variety of Explanations—First, if one travels in France on any but the recognized "crack" routes one is struck by the awful quality of the locomotive fuel—usually briquettes. The Frenchman says that this bad fuel must be used because the Germans destroyed the French coal mines in the north. Quite so. But in spite of that the German reparation deliveries of coal have been so much in excess of French requirements that France has been selling it back again to German industrial plants. If you ask the Austrian why his railway freight service is so bad he will tell you that he was obliged to suspend rolling stock renewals during the war, and that he had to cede large numbers of cars and other rail stock to the Allies. Yet the European central states have an abundance of stock for the present industrial demands and the existing volume of freight traffic. In other cases parts of systems have passed from the control of one state to another and the new owning state complains of the lack of experienced railway executives. This argument is found a great deal in Czechoslovakia. In spite of this there is actually no shortage of qualified executives, and numbers of Czechoslovakians filled important posts on the railway systems of what was formerly Austria-Hungary.

On top of these inconsistencies one is struck by the fact that the most progressive of the European systems are those most damaged by the war, namely in Belgium and north and eastern France. Here the entire devastation seems to have energized the railway forces to an amazing extent, and if one wishes to see what can be done in the way of reconstruction the systems mentioned afford the best examples available. Against this background of almost feverish activity in one section of Europe the indifference of the remainder is all the more sharply defined. Europe, to all intents and

purposes, appears to have adequate trackage, railway stock and a sufficiency of operators, yet something is lacking.

The Human Factor—That "something" can be attributed largely to the post-war outlook of the average railway employee. On the continent as well as in Britain, the main object six years ago was to win the war, so that any labor trouble which seemed to prejudice a successful issue was tided over to keep the services going. In this way extravagant promises of shorter hours and higher wages were made to pacify railway employees. After the war matters were different. Wages could no longer be periodically raised merely by turning out paper money. Similarly the rigid discipline during the war in the European armies left behind it a reaction against authority in any form. This fact no doubt accounts for the prolonged system of military control of a large number of lines after the war was over.

Unfortunately, so as to be able to get on with the business of war the politicians were forced to make to the workers, including the railway men, promises of a new heaven and a new earth, which could not possibly be fulfilled. Hence the labor difficulties.

Changes of government systems also played their part. The railwaymen had somehow been led to imagine that under republican government discipline was eliminated from the dictionary, whereas they found it was just as essential as under a monarchy. This disappointment was the foundation of the succession of railway strikes in most of the European states, but especially in the central European republics. Again, wartime railway expenses were enormously increased and receipts dwindled not quite, but very nearly, to zero. This deficit could only be met by state taxation. Keeping the railway systems going by state taxation meant the politician's opportunity, of which he was not slow to take advantage.

In this way the practical railway operator, unaccustomed to arguing but only wishing to hold down his job, did not make the same appeal to the public as the hare-brained political theorist, who gradually assumed control.

The peace treaties were also not without their effect. Germany had employed her railway systems as a political force and Europe would have no more of it, but the restrictions imposed by the politicians were framed without expert consultation and the results were nil. On the other hand, when conferences have taken place between European railwaymen and some concrete results obtained, the respective governments have usually refused to sanction them.

Little Technical Improvement—As might be expected from the rather uncertain atmosphere in which the European railways have found themselves laboring, little technical improvement has taken place since the war. Railway engineers in Europe developed a passion for electric traction but that seems to be passing. The reason for the cooling of this enthusiasm is due to the lack of the finances necessary to change over from coal to electricity. Those countries where cheap waterpower is available, notably in Switzerland, Scandinavia and parts of France, are pushing ahead with electrification schemes. But the majority have decided that steam is cheaper for the time being than electricity and are resigning themselves accordingly. This applies especially in the flatter countries like Holland and Belgium.

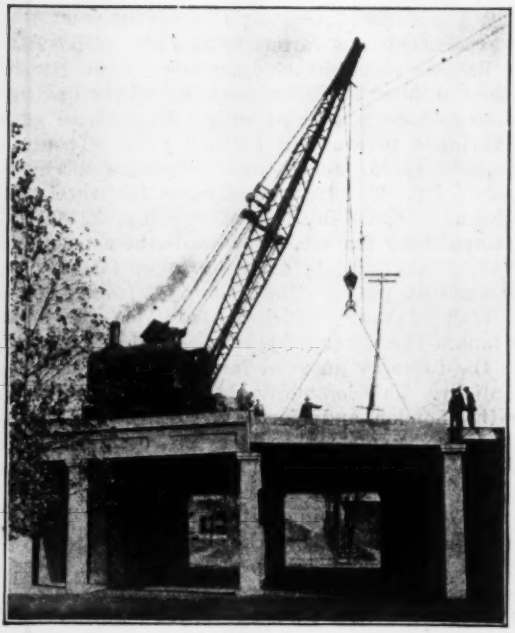
European railway engineers are not being slow, however, to experiment with various types of traction. Just now the Ramsay turbo-electric locomotive is being tried out on the Continent and promises well. In the Ramsay design the turbine is coupled with a three-phase generator having a pressure of 350-600 volts. There is also an auxiliary turbo-generator set with a d.c. generator of 75 kw. The tractive effort at the wheel rim at 60 m.p.h. is 6,000 lb., and at starting, 22,000 lb. The distinguishing feature, however, is the condensing equipment. This consists of brass tubes fastened in two circular tube plates. The whole unit revolves in a shallow tank of water which is fed from the main cooling tank. The water tubes are cooled by air forced through the tubes by an axial fan, the air leaving the tubes radially. This locomotive has already been tried out on the London and North Western Ry. on yard work, and has shown a coal economy approaching 50 per cent of that of the ordinary steam locomotive. Various European systems are experimenting with turbine locomotives. Norway is trying out a Ljungström turbine locomotive, Belgium has a Cockerill condensing engine on test and Switzerland is experimenting with Diesel-engined locomotives.

Aside from some of the main lines the passenger and freight rolling stock in Europe is very badly in need of repair or renewal. France is still using stock surrendered by Germany after the war with the original German distinctive marks untouched, and the cars also apparently untouched in any other way. All Europe needs new rolling stock and better care for the permanent way. On some of the country lines in France, for example, the permanent way is in a shocking condition, and one who is accustomed to British railway conditions wonders how the trains hold the track. Sometimes they don't, and derailments and collisions are very frequent on the Continent.

Europe's greatest trouble, in railway as well as other matters, is the politician. He has been allowed (in fact he could not be prevented) to get his finger into the railway pie and is very loath to withdraw it. When the technician and the trained railway executive again assume control the European railways will present a very different complexion.

Jubilee of the First Underground Railway

The sixtieth anniversary of the first underground railway or rapid-transit subway, which was the Metropolitan Ry., of London, was celebrated in January. This first section of the line was only 3¾ miles in length, from Bishop's Road to Farringdon St. It was of 7-ft. gage, but later a third rail was laid for standard-gage trains from connecting lines and eventually the broad gage was abandoned. Part of the work was in tunnel, with brick arch roof, and part was in "cut and cover" with brick walls and cast-iron roof girders supporting brick jack arches on their lower flanges. The steam locomotives had an arrangement for turning part of the exhaust into the tanks and the cars were lighted by coal gas stored in collapsible rubber bags on the roofs. Electrification began to be considered in 1895 and the first electrified section was opened in 1907. Steam locomotives are still used, especially on the open-air sections of the line. In 1863, the 3¾-mile line carried 9,455,175 passengers and its receipts were $508,535. In 1922, the Metropolitan Ry. had 93 miles of line (including suburban extensions on the surface), carried 180,500,000 passengers and had receipts of $9,800,000.

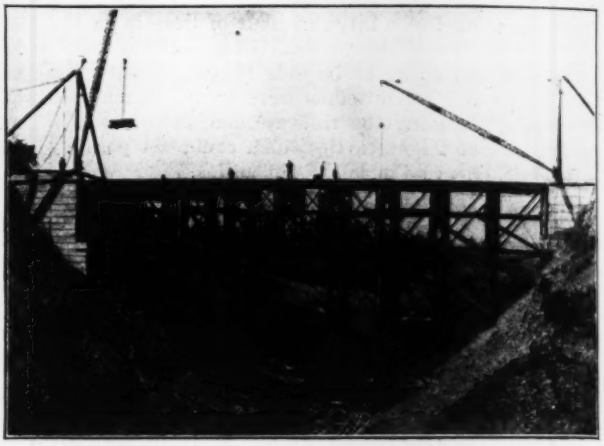


CHICAGO, ROCK ISLAND & PACIFIC RAILWAY
Placing concrete deck slabs on Chicago track elevation.
C. A. Morse, chief engineer.

ATCHISON, TOPEKA & SANTA FE RAILWAY
Construction trestle and fill at Crocker Creek on Eldorado extension.
C. F. W. Felt, chief engineer.

With the Railroads in 1922

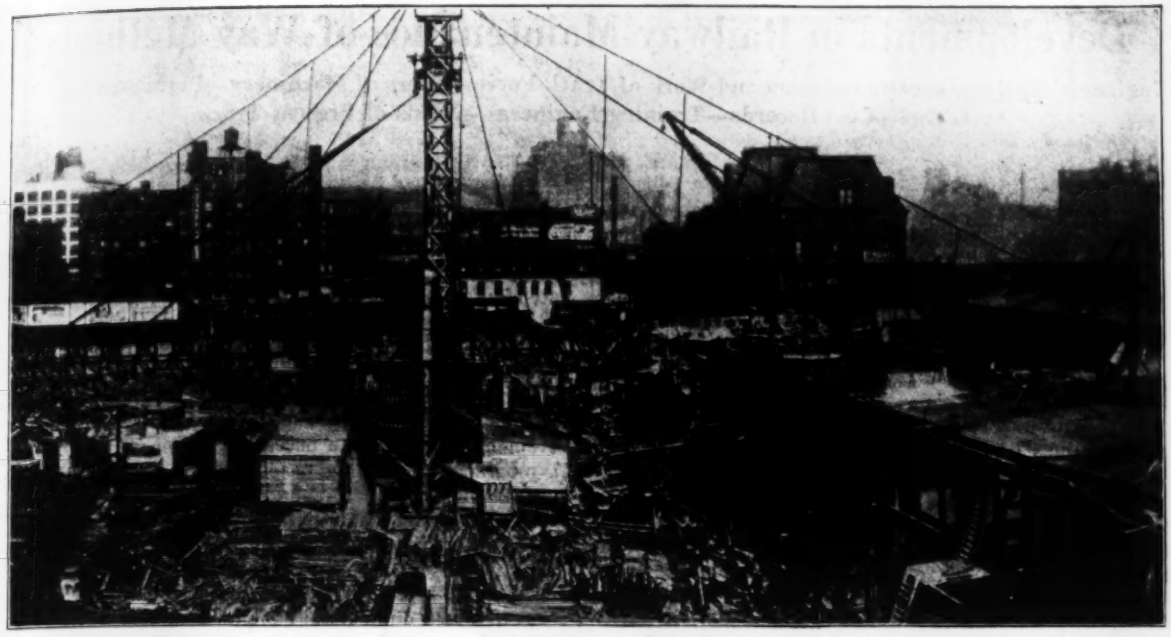
Ten Pictures From Here and There, Typical of the Railway-Construction Projects That Have Been Under Way on as Many Different Roads During the Year Just Past.



PENNSYLVANIA RAILROAD
Overcrossing on Summitville—Kensington grade improvement: Pittsburgh—Cleveland division.
A. C. Shand, chief engineer.

NEW YORK CENTRAL LINES
Construction trestle over Baker's Kill, Hudson River Connecting Railroad near Albany.
George W. Kittredge, chief engineer.

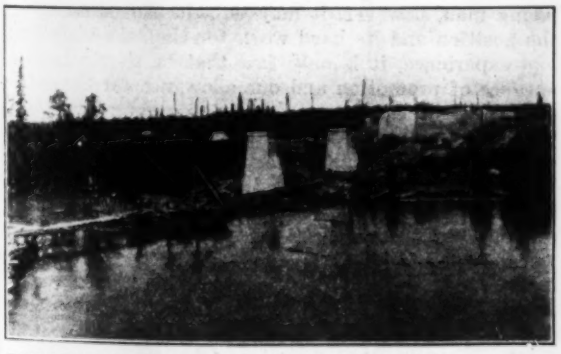
CHICAGO & NORTHWESTERN RAILWAY
Building concrete retaining wall for Milwaukee track depression.
W. J. Towne, chief engineer.



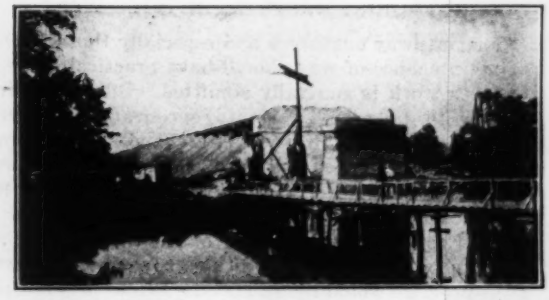
CHICAGO UNION STATION
Installing foundations for headhouse.
J. D'Esposito, chief engineer.

PHILADELPHIA & READING RAILWAY
Double-track 46-span concrete arch bridge over Susquehanna at Harrisburg. Arches each 66 ft. in clear; total length 3,500 ft.
Samuel T. Wagner, chief engineer.

SOUTHERN RAILWAY
Track elevation in connection with Ohio River bridge improvement at Cincinnati.
T. H. Gatlin, chief engineer of construction.



TIMISKAMING & NORTHERN ONTARIO RAILWAY
Cofferdam and piers for bridge on new extension.
S. B. Clement, chief engineer.



PERE MARQUETTE
North end of Flint River bridge on the Flint belt line.
H. A. Cassil, chief engineer.

Developments in Railway Maintenance-of-Way Methods

Engineers' Opinions on Organization and Work of Track Forces—Uses of Machinery—Permanent Section Gangs—Cost Records—Training Engineers—Needs of Present Track

By E. E. R. Tratman
Associate Editor *Engineering News-Record*

RAILWAY track and its maintenance have been the subject of considerable discussion and criticism during the past few years, both as to the track structure itself and as to its relation to the traffic which it carries. Perhaps suggestion for improvement might be a better term than criticism, since the trend of discussion has been constructive or progressive. This situation suggested an extensive inquiry concerning the views of railway engineers and track officers as to possible lines of development in the work and organization of the maintenance-of-way department. The results of this inquiry are reviewed below and cover the following subjects: (1) Training engineers for track maintenance; (2) the organization of permanent section forces; (3) the relative advantages of work by section gangs and extra gangs; (4) machinery for track work; (5) housing and living accommodations; (6) piece-work and cost record systems; (7) methods of improving track and the efficiency of track work.

Before proceeding to this review it will be of interest to note briefly some of the suggestions which have been made for improvement in track and maintenance. They include the following: (1) More engineering supervision; (2) better economics of expenditures or assignment of funds; (3) more consistent programs of work; (4) better and more permanent working forces; (5) wider use of machinery and mechanical appliances, and (6) general improvement of track structure to put it in more economic relation to the traffic and loads which it carries. Along some of these lines the engineer is practically powerless to introduce any material changes or improvements, since they are governed largely by the financial conditions of the railways and the ideas of management and administrations. However, the engineer may find opportunity to inform and convince the higher and non-technical officers as to the economic aspects of track and maintenance work.

Where roadmasters and supervisors are mentioned in this article, it must be remembered that the qualifications and titles vary greatly on different roads. In some cases the supervisor is practically a super-foreman and in others he is identical with a roadmaster, or he may even be an engineer. The roadmaster also may be either a "practical man" or an engineer.

Training Engineers in Track Work

That railway engineers and especially those in charge of maintenance-of-way should have practical experience in track work is generally admitted. But few railroads appear to take any steps to encourage engineers to obtain experience in the maintenance department or to place them in such positions as roadmasters or supervisors with a view to later promotion in the maintenance branch of the engineering service. In fact, several roads state definitely that nothing is done along this line of development, although some consider that such practice would be beneficial. While it is not necessary that an engineer in charge of track should be an expert trackman, his efficiency will be increased materially if he has had some actual experience of the work and actual contact with the men who carry it on.

Appointing young engineers as roadmasters or superintendents of bridges and buildings is regular practice on a few roads and is preliminary to appointment as assistant engineers and then division engineers, or engineers of maintenance-of-way. Only a certain proportion of the roadmasters are selected in this way, however, as it is desirable to offer opportunities for section foremen who show the necessary ambition and ability. A modification of this practice is to have the young engineer begin as a roadmaster's clerk and work up as general foreman or assistant roadmaster, but always with the engineering staff of the maintenance-of-way department as his objective. A practice followed by some roads is to try out engineering students in the section forces during the summer and those who prove satisfactory may be given permanent employment after graduation, working up from roadmaster to assistant engineer. One road is planning to extend this method, since it is concluded that the practical experience in work and especially in the handling of men is beneficial for those holding the position of division engineer. This is particularly the case where the organization is such that the division engineers have charge of maintenance-of-way and structures.

An alternative to this system of developing engineers through the position of roadmaster is the establishment of a special apprentice system for training engineers in track work and then advancing them to the lower positions in the engineering force. Under this system, however, they do not always receive the experience and responsibility of handling men, which is one of the most important features.

Even where the opportunity is given for experience in track work the result is not always satisfactory. From a road which has developed some of its engineers in this way comes the report that many young men are unwilling to submit to what appears to them the drudgery of track work, the restrictions upon their time and the liability of being called out for extra or emergency work. Yet it is this discipline and experience which may make them valuable later. On the side of the young man, however, it may be said that if he accepts the position and its hard work for the sake of training and experience, it is only fair that he should have assurance of promotion and due allowance for the experience thus gained.

In the year past, railways have had the reputation of taking the attitude that the young engineer must work hard for very little pay and without assurance of advancement. This attitude undoubtedly has had a strong influence in rendering railway work unattractive. In fact, an engineer of a large railroad states that lack of success in training engineers through the position of roadmaster is due to the low pay and uncertain promotion.

The usual practice appears to be to train roadmasters as section foremen and to train engineers as axemen

and rodmen. Reports from a few roads state definitely that the roadmasters should not be engineers, all work of an engineering character being done by the engineering staff. Similarly, the engineers, should not be trained in actual track work but should rely on the roadmasters for expert advice. This view of the case, however, is evidently that of a small minority.

Conclusion—As a general conclusion, it may be said: (1) Modern maintenance-of-way work requires a high degree of technical knowledge; (2) there is a wide appreciation of the value of track training for the railway engineer; (3) there is no general policy or system of providing or offering such training; (4) little encouragement is given to the young engineer to identify himself with the track or maintenance department; (5) where a definite system of training continued with promotion has been carried out the results have been highly satisfactory; (6) it would be well for the railroads and their engineering departments to give more serious and practical consideration to a policy of making the maintenance-of-way department attractive to the young engineer.

Permanent Section Forces

Until very recent years track work has been regarded as necessarily seasonal, with the result of the universal practice of recruiting the force every spring and reducing it in the fall, just when the men have become trained and efficient in their work. This policy has been bolstered up by the general but erroneous assumption that track work is unskilled labor, requiring mainly muscular ability. Against the money saved by discharging men must be set the loss in work done inefficiently and materials wasted or damaged by inexperienced labor.

There is now a growing recognition of the fact that a man experienced in track work is a valuable asset and that some means should be taken to retain his services. The obvious method is to spread the track work over the entire year and thus provide permanent employment, instead of crowding the work into six to eight months. Careful study of the work has shown that many kinds of work can be done successfully throughout the winter, except during periods of severe storm or temperature.

To some extent the work is necessarily seasonal, especially in certain sections of the country where the working season is definitely limited by prolonged periods of severe cold or heat. Of thirty-four railroads, fourteen are using the permanent force system with success, ten believe in this system but are not using it and ten prefer the present system. It is instructive to note that one road in a cold northern mountainous district considers that even on such a road it would be practicable to find work for the section forces through the winter. On the other hand, the system is not universal even in the warm southern states.

Geographically arranged, railroads which use the system include eleven lines in the south, southeast and southwest and one each in the east, central and northwest districts. Each of these last three, however, uses it by maintaining minimum permanent gangs. Of two roads which approve the system, one would provide for the heavier summer work by enlarging the section gangs, while the other would have it done by extra or floating gangs.

Although twenty-four railways approve of the system and fourteen of these are using it, there are two lines of opinion as to the organization. On the one hand it is suggested that the permanent force should be a strong one, requiring only a few extra men for summer work. On the other hand it is claimed that the permanent force should be a minimum, or practically equivalent to the present reduced winter force. It is evident that the first is the better and more reasonable plan. Under the second plan, the very advantage sought by maintaining a permanent force would be lost, since this plan would perpetuate the present objectionable system of employing a large number of green men for a few months. One engineer points out that under conditions which now require eight men in summer work and four in winter, it would be better practice to have six men permanently employed.

Since it might still be necessary to engage extra men in summer, the permanent-force plan might seem at first to differ very little from the ordinary practice of alternately increasing and reducing the section forces, but the difference really is of the utmost importance. In the one case, the section foreman has a permanent force of skilled and experienced men who know what track work is and how to do it, and who have an interest in their work and in their employer. For the busy season he may have to employ a few extra laborers. In the other case, the experienced men probably would not stay with the small winter force. Even if they did stay the foreman would have to engage a number of green men in the summer, spend his time in instructing and watching them, only to discharge them just when he has got a trained gang, at the end of the season.

Conclusion—A conclusion based on the various individual reports is that there is a large opportunity for effecting improvement in the track department by expanding the general economics of the "permanent-force" system and investigating the advantages or possibilities of its application in individual cases.

Section Gangs versus Extra Gangs

Whether the work of section gangs should be or should not be supplemented by that of floating or extra gangs appears to be an open question, but with a strong majority opposed to such assistance.

It is true that practically all railroads operate extra gangs, but they are employed mainly on heavy and extensive work which is not properly within the field of the section forces. Thus on tie or rail renewals, ballasting and widening cuts, or even in general surfacing, it may be more convenient and economical to put one track out of service for a time in order to do a large amount of work with a special gang on a long stretch of line, rather than to do it piecemeal by the maintenance gang or individual sections. With the latter procedure the work would have to be done under traffic, with consequent mutual interference of work and train service.

Several section gangs are sometimes combined for such extensive work. But the men are not trained to work together, so that they will be less efficient than a large extra gang accustomed to working as a unit. Furthermore it is generally considered inadvisable to make a practice of taking the section men away from their own sections, as this tends to loss of morale and of interest in their regular work.

As to maintenance work proper there are two lines of opinion. On the one hand it is held that the section gang should be only of such size as to attend to the

putting in of occasional ties, lining and surfacing track, policing or inspection and the cleaning of ditches and right of way. All other maintenance, including such a specialty as turnout work, would then be done by floating gangs. This plan was advocated very strongly at one time, but has not come into extensive use. One argument given in its support is that the section forces change annually and thus have little experience with other than "pick and shovel" work, while the extra gangs are more permanent and therefore more proficient. This argument loses much of its force if considered in relation to the question of permanent section forces, as discussed previously.

That as much work as possible in each section should be done by the section gang is the more general opinion of engineers, roadmasters, and other railway officers. In support of this opinion, it is urged that work will be done more efficiently by men who are directly responsible for it and are not shifting from place to place. Similarly, both the foreman and his men will feel less interest or responsibility if they know they are to be helped (or interfered with) by an extra gang.

Where all maintenance work is left to the section forces the men will acquire a knowledge of the various kinds of special work. Furthermore, it appears to be generally considered that a floating gang is not likely to do the routine or minor maintenance work as well as a local section gang, upon which responsibility can be placed directly for negligence or defects. It is considered also that such work involves much loss of time and money in getting the extra gang to its work at various scattered points, since it would rarely be practicable to work from section to section. Another objection is that the foreman of the extra gang would be apt to slight the finishing of one job in order to move on to the next. However, it should not be difficult to train the foreman to realize that he is held responsible for finishing up his work completely and properly.

Of reports from thirty-three railroads, only four are definitely in favor of employing minimum section gangs and leaving to extra gangs all the heavier and more special items of track maintenance, as well as all kinds of renewals and improvements. The others either favor limiting the extra gangs to special duties, heavy work and emergencies, or suggest some slight assistance to the section forces. As to this latter point, however, some consider that it is better to enlarge the section forces than to do part of their work by extra gangs.

Conclusion—A definite conclusion appears to be that practically all track maintenance work should be done by the section gangs. While extra gangs are a necessary part of the railway organization their work should be on improvements and heavy replacement rather than on maintenance.

Machines for Track Work

One of the most obvious and important steps for effecting a high degree of efficiency and economy of track work is the introduction of labor-saving machines and devices, thus securing a greater output at lower cost and with a smaller force. Many present and prospective economic applications of machinery have been noted in *Engineering News-Record*, May 18, 1922, p. 824. For example; ditching is done by machine at 2 to 6c. per cubic yard as against 75c. to $2 for hand labor; weed killing averages $19.50 per mile instead of $175; and rail renewals average $500 instead of $1,400 per mile. These few examples illustrate the great economic advantages of machine work. Furthermore, much of the work done by machinery is of the rough and heavy character which is repellent rather than attractive to the laborers. Space does not permit any detail description of the various machines or their work as mentioned in the replies from numerous railways, but the following lists outline their diverse kinds and applications:

A.—Machinery and Appliances for Light Work:

1. Electric ballast tampers and rail drills.
2. Pneumatic appliances for tamping ballast, driving spikes, drilling rails, turning nuts on track bolts, oiling track, sandblasting steel, riveting and chipping on bridge work, boring ties and timbers.
3. Spike setters, pullers and straighteners.
4. Tie borers, tie pullers and tie-spacing clamps.
5. Sod line cutter and ballast toe liner.
6. Weed cutters for track and shoulders.
7. Portable rail saws.
8. Track oilers, to prevent corrosion.
9. Oxyacetylene outfits for cutting, drilling and welding rails and frogs. But some track men doubt the advisability of cutting or drilling rails in this way.
10. Motor section cars to carry men and material to and from work.
11. Narrow-gage dump cars for use in widening cuts and cleaning ditches.
12. Track dollies and rolls for moving ties and timbers.
13. Light pile driver for fence posts.
14. Wood working outfits for use on bridge falsework and concrete forms.

B.—Machinery and Appliances for Heavy Work:

1. Ballast cleaning and screening devices.
2. Ditching machines for cleaning track ditches and widening cuts.
3. Spreader cars for leveling dumped material.
4. Small rotating steam shovels for ditching and light earthwork.
5. Dump cars for use with ditchers and steam shovels.
6. Ballast cars and plows.
7. Weed killers: using chemicals, steam or oil flame.
8. Rail sawing and drilling outfits for reclaiming damaged rails.
9. Small rail-laying cranes or derricks for use in laying single rails.
10. Rail and tie handling devices for loading and unloading cars.
11. Locomotive cranes for handling and laying rails, frogs and crossings; handling earthwork and ballast with grab buckets; handling scrap with bucket or magnet.
12. Derrick cars and wrecking cranes for handling heavy material, laying rails and driving piles.
13. Portable concrete mixing outfits for small jobs.
14. Thawing outfits for clearing snow and ice from switches.

Few suggestions were made in answer to a query as to new applications for machinery, but several engineers consider that there should be a much wider use of machines now available, since so large a proportion of maintenance work can be done by machine. It is pointed out that they are likely to prove highly economical where there is sufficient work to keep them busy.

Two suggestions are for simpler devices for cleaning ballast, although two or three such devices are now in use. Others are for a gasoline rail-drill and a vacuum-cleaner on a large scale for use at terminals and yards. Still another is for a tie-spotting machine to dress the rail seats of ties in the track, but with treated ties all boring and trimming should be done before treatment. It is suggested also that some electric tools are of lighter weight than pneumatic tools, so that there is opportunity for further development of the former as

well as improvement of the latter. Home made devices have been rigged up in a number of cases and for a variety of purposes, but their use is limited.

More than one engineer points out that as a rule the detail work takes up so much of supervising officers' time that they have little opportunity to study or devise improved methods and machines. In fact, from two roads comes the suggestion that some of these officers or a special officer might be assigned to investigate the possibilities in this direction and to make recommendations accordingly.

Conclusion—All of the above information points to the conclusion that a much wider use of machinery may be expected within the next few years, even though no new uses or new machines are introduced.

Housing and Living Accommodations

In view of the importance of the labor item and the acknowledged difficulty in getting and keeping men on railway maintenance and improvement work, it is strange that there has not been much greater progress in providing improved accommodations for section, extra and bridge gangs. There are several individual cases of radical change from old practice, but in general the facilities include old buildings and camp cars with more or less unsanitary conditions and unpleasant surroundings. The various replies indicate very plainly that there is a large field for improvement in the accommodations provided for the working forces, and that work in this field promises tangible results. It is not to be assumed that the labor problem will be solved by means of comfortable camps and good food. The human element is too diverse for such a result. Men will still leave for slight reason; because of a dislike for the work, the gang, the foreman or the food; because a friend is going or an enemy is not going, or simply because of the urge to move on. If a man knows his employment is only temporary, he feels he may as well go now as later. But there comes in the question of permanent forces, already discussed. If a man knows that he has a permanent or even long-time job he will put up with many real and fancied grievances, any one of which otherwise would be ample reason for quitting. If these grievances are reduced to a minimum by his employer, so will his tendency to quit be reduced. The ultimate result of careful attention to this living and housing problem is expressed tersely by an engineer of long experience in the two words: "It pays."

Piece-Work and Cost-Record Systems

A serious difficulty which faces attempts to increase the efficiency and economy of railway track work and general improvements is the lack of means for determining the output per man or per gang or the unit cost of the items of work performed. In the first place, the men usually receive a regular and uniform wage. In the second place, the only basis for cost data is in the inadequate and arbitrary entries of the section foreman or gang foreman in his time book. To quote from a paper by Mr. Ford, assistant chief engineer of the Chicago, Rock Island & Pacific Ry.: "In general the productivity of railway maintenance labor has not been commensurate with results secured in other lines of industry where measures have been used for gaging output" (see *Engineering News-Record*, May 18, 1922, p. 824). One engineer says present systems of maintenance-of-way accounting are of little value to the men in charge of the work.

Various cost-record systems have been tried by thirteen out of thirty-six railways, but in only one case has the system been introduced to any extent. In most cases the innovation is regarded as experimental and inconclusive; in general also the system is limited to obtaining unit prices for certain typical and specific items of work, such as tie renewals, ballasting and rail renewals. In fact one engineer considers this decidedly preferable to attempting to apply the system to the entire work, since it allows of definite comparisons being made and avoids the considerable expense of an accounting system which covers all details of the work. He considers that the three items mentioned would be typical and comparable throughout the railroad.

On the other hand, several engineers approve of a general cost-record system and consider that a simple, fair and efficient system could be worked out to determine unit cost and the relative efficiency of men and gangs. Reasons given for not carrying out a study along this line are mainly in regard to insufficient force and funds. An objection noted is in the varying local conditions of track and traffic, making general comparative data of questionable value. But this objection is avoided in some cases by making the comparisons between sections or districts requiring about the same character of maintenance and having about the same traffic.

A cost-record system for track maintenance work on the St. Louis-San Francisco Ry. is found to effect a saving of money and to result in good work being done (see *Engineering News-Record*, Nov. 11, 1920, p. 949). An improvement on the ordinary time-book plan as introduced by one road is to have the foreman send a daily report to the roadmaster and the division engineer, giving all information necessary for the complete accounting of the work done by the gang. This is found preferable to monthly reports; it gives the division officials a better check on their expenditures, and it is approved by the foreman since it frees him from all the bookkeeping which formerly was necessary. Another road has experimented with measuring the cost in man-hours of performing certain items of work with a view to rivalry among the section foremen and a resultant economy. It appears to be quite generally considered that real improvement, but with intangible and indefinite economy, results from the practice of periodical inspection with award of prizes. This practice is not now so general as it was some few years ago and several engineers favor a return to it.

As to the piece-work system, only four of the thirty-six railroads report having tried this. Two of these roads had to abandon it during the period of control by the U. S. Railroad Administration and have not yet resumed it. A third has a large proportion of its work done by contracting directly with the laborers and paying them by the unit of work performed. An objection cited in one case is the dissatisfaction likely to result from different pay to different members of the gang, with probable suspicion of favoritism on the part of the foreman. But this difficulty does not appear to have been encountered in the methods actually put into use.

Conclusion—Here again the conclusion may be presented that there is a fine opportunity for thorough investigation. Its objects would be as follows: (1) To determine the advisability and feasibility of a cost-record system and a piece-work system in railway maintenance work, and (2) to devise such systems in suffi-

cient detail for their introduction both for the field or working force and the office or accounting force.

Improving Efficiency in Track Work

We come now to the suggestion of means or methods for improving the efficiency and economy of railway maintenance work and its organization. Several suggestions were made in the returns from individual railways, but few of these were discussed in any detail. In general they may be condensed and listed as follows, the figures in parenthesis indicating the number of persons making each suggestion:

A. Prepare a financial program, inform the maintenance officer how much may be spent per mile and then let him do his work without interference. Under the present system it is not so much a question of how much should be spent on a certain piece of road and in relation to its traffic, but rather how little can be spent, irrespective of requirement. This system is discouraging since the maintenance organization is not fully informed as to what it will be allowed to do. But it is admitted that this is difficult or impracticable under present financial conditions. (Four.)

B. Prepare a work program by which the items interfering with traffic (such as rail renewals and ballasting) will be done during the period of minimum traffic; that is, usually in the spring. (Five.)

C. Introduce a cost-data system and better accounting for close and accurate comparison of unit costs and gang performance. (Seven.)

D. Organize better clerical forces on maintenance and construction work. (One.)

E. Bring more men of technical education and railway engineering experience into the maintenance-of-way-department, and put this department on a plane equivalent to that of the maintenance-of-equipment department. (Three.)

F. More extensive use of labor-saving machinery and devices. (Seven.)

G. More thorough supervision of track work by supervisors, roadmasters and engineers. (Eight.) One of these suggestions includes shortening the roadmasters' divisions to provide for increased supervision.

H. Standardization of track work. (One.)

I. Heavier track construction in proportion to the loads and traffic carried. (Three.)

J. Permanent track forces. (Five.)

K. Definite training of men as section foremen, with pay sufficient to attract good men. (Three.)

L. Better pay for laborers. (Four.) Two of these suggest piece-work or payment by performance.

M. Better housing of laborers, foremen and extra gangs. (Five.)

N. Contract system of maintenance-of-way. (Three.) One suggests contracting work with laborers. (An extended article on the contract system was given in *Engineering News-Record*, Oct. 26, 1922, pp. 683, 702.)

O. Return to the former system of regular track inspection by superior officers, with award of prizes in money or in signs displayed on the winning sections. (Four.)

Supplementing the previous subject, inquiry was made as to the class of work most needed at the present time to put main tracks in condition for economic operation and maintenance. Naturally the replies varied with personal opinions and local conditions, but they may be classified generally as below. It is of interest to note the relatively small demand for new or heavier rails as compared with that for ballast, drainage and ties. An explanation of this is given by one engineer who remarks that new rails will not compensate for inadequate ties, ballast or poorly drained subgrade.

A. Drainage and ditching, including tile drains. (Twelve.)

B. Ballast of better quality and greater quantity. (Fifteen.)

C. Ties of better quality and in greater number. (Eleven.) Only three replies refer specifically to treated ties, and three advise the wider use of tie-plates.

D. Rails of heavier weight or new rails to replace those worn and battered in service. (Eight.)

E. Rail anchors as an aid to track maintenance. (Two.)

F. Better rail-joints as an improvement in themselves and as influencing the service and life of rails and track. (Two.)

G. More attention to general maintenance of gage, line and surface. (Eight.)

H. Intelligent and competent trackmen and foremen, and trained foremen and supervisors. (Two.)

I. Replacing old bridges with more permanent structures. (One.)

J. Regulation of train speed in relation to conditions of grade, curvature and track. (One.) Improvement in this direction is hardly to be expected. Schedules rarely take such factors into account, except when they are so severe as to be governing factors. In general, the maintenance department has to maintain the track under practically any and all operating conditions.

Conclusions

A study of the several subjects covered in this article suggests the following conclusions:

1. There is need of more engineers specially skilled in track work and need also of more skilled track foremen. But in general the railways are doing little to invite or encourage engineers to specialize in this department. Nor is there any general or definite policy of training foremen, who are the important non-commissioned officers in charge of the working forces.

2. The employment of permanent instead of temporary or shifting forces promises economic and practical results of high value. As a corollary to this, a permanent skilled section force should do all regular maintenance work. Extra gangs would still be needed, but would handle only improvement and emergency work and heavy replacements. Greater attention to the living conditions and social needs of the men is desirable.

3. Machinery for track work is increasing in extent and in variety, but the present demand is for wider use of the machines available rather than the development of others for additional purposes. It is particularly important to note that much of this machinery is to relieve the men of work that is severe or unpleasant.

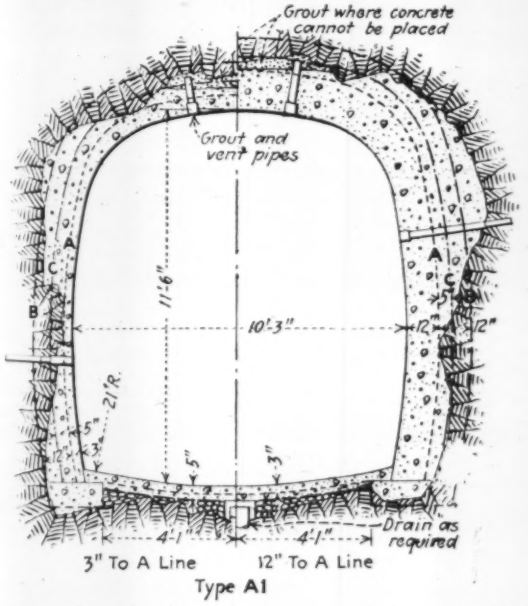
4. Cost-record systems are needed in order to permit of determining output performance and unit costs. Few railroads have systems giving results comparable with those employed in other lines of engineering work.

5. Extensive improvements are needed to bring the track into economic relation with the traffic. These improvements are needed more particularly in the substructure (roadbed and ballast), rather than in the rails which form the superstructure, although it is often assumed that heavy rails are needed first and will compensate for defects in the substructure.

World's Longest Continuous Tunnel Holed Through

On 18.1-Mile Shandaken Bore for New York's Catskill Water Supply Rock Excavation Totaled 573,000 Cu.Yd.

WHEN a thin wall of rock separating the headings between shafts 1 and 3 of the Shandaken tunnel of the Catskill water-supply system for New York City was blasted down at 3 a.m., Feb. 13, the last barrier in the world's longest continuous tunnel, 95,740 ft., or about 18.1 mile, was removed. In length, this tunnel exceeds by 51 ft. the 95,689-ft. city aqueduct tunnel, also part of the Catskill system, for the delivery of the supply within the city limits. The total payment quantity of rock excavation on the Shandaken tunnel is approximately 573,000 cu.yd., while the amount per linear foot



TUNNEL SECTION SHOWING CONCRETE LINING

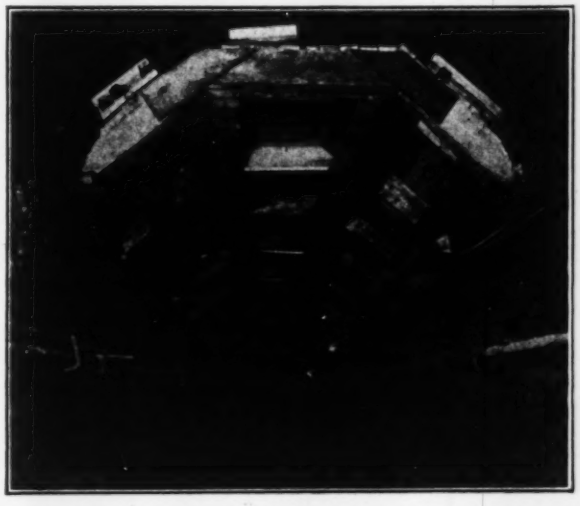
The "A" line is the line beyond which no rock shall project.
The "B" line is the line of payment for excavation and concrete.
The "C" line is the line of average thickness of lining in any 4-ft. length of tunnel.

varies from 6.64 to 7.73 cu.yd. For concrete lining the yardage per foot of tunnel ranges from 1.87 to 2.64.

The water tributary to the Catskill water supply system rises in the Esopus and Schoharie watersheds in the Catskill mountains. Each of these watersheds will furnish a supply of about 300,000,000 gal. a day. The Esopus development was practically completed in 1917 and work on the Schoharie is now in progress. The Shandaken tunnel will conduct water from the Schoharie reservoir into Esopus creek, which flows directly into the Ashokan Reservoir.

This tunnel is horseshoe in section and concrete lined, with finished dimensions of 11 ft. 6 in. in height by 10 ft. 3 in. in width. Its carrying capacity will be about 600,000,000 gal. a day. It has a uniform slope of 4.4 ft. per mile except for the northerly 3½ miles, which is depressed, making that portion a pressure tunnel. Seven intermediate shafts were provided, the aggregate depth of shaft being 3,238 lin.ft.; the maximum depth of a single shaft is 630 ft. The minimum distance between shafts is 1.3 miles and the maximum 2.7 miles; however, as actually excavated the maximum distance between shafts was 4½ miles.

The estimated cost of the tunnel is $12,138,738, and the original contract was awarded in December, 1917. War conditions interfered with the progress of the work during the early stages and on Nov. 10, 1920, the work was assigned to the Shandaken Tunnel Corp., New York City, at which time all shafts had been sunk and lined, tunnel headings turned, an electric power line



PERMANENT TIMBERING IN SHANDAKEN TUNNEL
About 48.3 per cent of the tunnel required support.

installed over the entire tunnel location and 11,300 ft. of tunnel excavated.

Record of Progress—The first headings were holed through April 1, 1922, between Shafts 4 and 5, and concreting operations were started in this portion shortly thereafter. In the 2 years and 3 months following Nov. 10, 1920, 16 miles of tunnel were excavated and 7.9 miles lined with concrete. The maximum progress made on the excavation of the tunnel was as follows:

Progress of Tunnel Excavation	Feet
Max. monthly excav. in 12 headings	5,979
Max. weekly excav. in 12 headings	1,430
Max. monthly excav. in 1 heading	611
Max. weekly excav. of completed tunnel in 1 heading	164
Ave. weekly excav. in all headings	62
Ave. weekly progress, all headings, after Nov. 10, 1920	78

The rock through which the tunnel was excavated consisted of shale or sandstone varying widely in hardness. The beds were of varying thickness and the general dip of the formation was from 1½ to 2 deg. toward the south. The shales, mostly red with small amounts of blue and green, drilled easily and broke well to line but had a marked tendency to disintegrate rapidly when exposed to atmospheric conditions. The red sandstones were of slightly coarser texture, and roof support was usually required, as in all of the shale ground. The gray and blue sandstones were the hardest and coarsest grained, and consequently were more difficult to drill and shoot, required little scaling and when not too thinly bedded generally stood well without support. The inflow of water was never so great as to impede the work or to require other than ordinary methods for its control.

The top-heading method and hand mucking were used practically for the entire period in Shafts 1, 3, 4, 5 and 7 (south) and the full-faced method with machine mucking at Shaft 6 (south) and Shaft 7 (north). At the

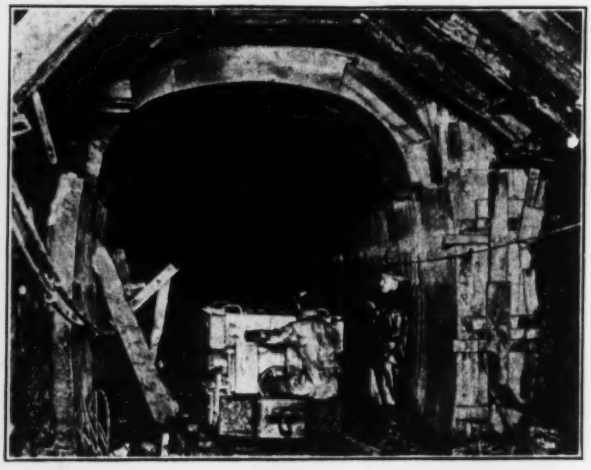
EXCAVATION PROGRESS—SHANDAKEN TUNNEL

Shaft	Tunnel Heading	Length (Ft.)	Supported Lengths (Ft.)	Elapsed Time (Weeks)	Aver. Weekly (Ft.)	Max. Weekly Completed Tunnel (Ft.)	Material Excavated
Intake	S.	16	0	4	4	12	Rock
1	N.	11,886	1,508	152	78	150	Rock
1	S.	13,357	0	166	80	155	Rock
2	N.	33	0	3	11	22	Rock
2	S.	709	0	13	60	119	Rock
3	N.	9,721	1,557	115	85	148	Rock
3	S.	6,664	2,677	100	67	151	Rock
4	N.	6,253	1,158	69	91	164	Rock
4	S.	4,791	1,904	53	90	150	Rock
5	N.	6,407	4,745	**123	52	138	Rock
5	S.	6,483	3,606	**123	53	130	Rock
6	N.	6,849	6,711	128	54	99	Rock
6	S.	8,333	8,330	150	55	114	Rock
7	N.	5,952	5,806	**160	37	84	Rock
7	S.	7,928	1,366	**162	49	155	7,614 ft. rock 314 ft. earth
Portal	N.	220	272	17	13	28	
Totals		95,602	*39,640	1,538	62		
After Nov. 10, 1920		84,302	37,109	1,078	78		

Note: The above lengths of tunnel between shafts do not include the portions of the tunnel which were excavated as shaft.
* In addition there was 6,564 feet of temporary support.
** No work for 16 weeks at 5 North
No work for 23 weeks at 5 South
No work for 21 weeks at 7 North and South

outlet portal there was 600 ft. of difficult soft ground work. Shifts were in general so organized as to permit of two shots per day in the top heading tunnels and alternate advances of two shots and one shot per day in the full faced tunnels. Trimming was carried on closely behind the main excavation. Water Leyner drills, mounted on vertical columns, were used in the headings and jackhamers on the bench.

No tunnel excavation was done from the intake shaft nor from Shaft 2, and only a few hundred feet of the soft ground was taken out from the outlet portal. The distance between Shaft 1 and Shaft 3, the maximum between shafts as excavated, was 23,819 ft. or 4½ miles. From May 4, 1921, to Feb. 13, 1923, when this stretch was holed through, a period of 94 weeks, the average weekly progress was 208 lin.ft. in these two headings.



CONCRETE LINING IN PLACE
Showing electric storage battery locomotive used to pull seven cars.

Transportation of tunnel muck to the shafts was accomplished by means of electric storage-battery locomotives, pulling six or seven end-dump cars, each averaging about 1 cu.yd. of solid rock.

Roof support by either permanent or temporary timbering, of practically the same design, was necessary in 48.3 per cent of the tunnel length. In the temporary type the timber was placed within the concrete limits and will be removed before the lining is placed.

Tunnel lining has been carried on since April 5, 1922, when the first concrete was placed. This work has been done from plants located at Shafts 1, 4, 5 and 7 and to date 42,069 lin.ft. of tunnel have been concreted, equivalent to 44 per cent of the total. The maximum rate of concreting per week for the entire contract has been to date 1,454 ft., and from one shaft 1,082 ft.

This construction is being done by the Board of Water Supply of the City of New York, of which Thaddeus Merriman is chief engineer. George G. Honness is department engineer in charge of the field work, and William B. Hunter and Roy W. Gausmann are the division engineers.

The representative of the Shandaken Tunnel Corp. on the work of construction is the Ulen Contracting Corp., of which Henry C. Ulen is president and Thomas S. Shepperd is general manager in charge of all construction operations. M. R. Keefe is general superintendent for the Ulen corporation, G. E. Hines is chief engineer and R. H. Keays is assistant general superintendent.

Gum Wood for Ties on Santa Fe Ry.

Although gum wood is generally regarded as undesirable for ties, owing to its tendency to extensive checking which promotes decay, it has been found very satisfactory on roads which have given it special attention, according to a paper read at the recent convention of the National Association of Railroad Tie Producers, at New Orleans, by J. R. Keig, manager of the Kirby Lumber Co., Silsbee, Texas. Mr. Keig referred especially to practice and experience on the Atchison, Topeka & Santa Fe Ry., stating that on this road it was realized that gum ties could be used with success if moved from the woods immediately to the track or loading point, properly stacked for inspection or loaded promptly for the treating plant, given the necessary care during seasoning, and then treated according to the most improved methods. The principal species are red or sweet gum, black gum, cotton gum or tupelo, and are found in the low-lands, usually along the rivers.

When ties are hauled to the right of way, they are not accepted unless indications show that they have been brought out almost immediately. They are stacked on the right of way (two by seven) with plenty of air space to facilitate inspection and seasoning, and every precaution is taken to load them before there is chance for infection. When ties are seasoned and ready for treatment they are sent to a boring and adzing machine which also cuts a slice from each end so as to permit an inspection of the wood. If a tie proves to be unsound, it is culled out. After thorough treatment, usually with creosote, the ties are stored in the yard or shipped to one of the many storage yards.

Gum ties (which are considered as hardwood) are used only on curves of two degrees or over, on heavy traffic main lines or switching leads, and on certain mountain division. They are inserted with care, which means the use of tie tongs and freedom from undue abrasion. Tie-plates are used, but it is said that there is little plate cutting of the tie and that the spike holding qualities are excellent. The Santa Fe Ry. is reported to have one instance where gum ties have given thirteen years service with only one per cent renewals.

Further Track Test Data: Rail Stresses and Track Distortion on Curves

Third Report of Track Stress Committee—Action of Locomotives on Curves, and Vertical and Lateral Rail Bending Developed—Load Distribution Changed—Track Distorted by Wheel Pressures

IN THE third report of the Committee on Stresses in Railroad Track, just published, new facts are brought to light fully as important as those contained in the two preceding reports. They define the principal phenomena of curve effects, both as to locomotive action and as to track resistance. For better comparison the report also analyzes the vertical and lateral effects on straight track more fully than was possible in the earlier reports.

Convenient summaries of the first and second reports were presented in *Engineering News-Record* of March 14, 1918, p. 517, and Feb. 26, 1920, p. 406. As there summarized, the two reports demonstrate:

First Report—Rail stresses are determined not by beam action between adjacent ties, but by the general track depression under the group of loads concerned; track depression and rail stress are proportional to the load; the rail stresses are greater for larger wheel spacings, lower on good roadbed than on bad, lower in heavy rail than in light, and greater for high speeds than for low by amounts ranging from 0.3 to 1.2 per cent for every mile per hour increase of speed beyond 5 miles per hour. Generally speaking, the stress in the outer flange of the rail exceeds that in the inner flange, but the rail is bent laterally into a sinuous form.

Railway roadbed is elastic, but with an initial inelastic deformation, which may be considered looseness or play. Measurement of the elastic constants of the track is simple and accurate, and calculations made with the use of these constants and the principles of the ordinary flexure theory give calculated stresses which check the measured stresses in the rail very closely. The distribution of the locomotive load between the several wheels has an important bearing on rail stress; for example, a defective equalizer lever produced abnormal stresses under one wheel.

Second Report—Rail stresses under drivers increase and decrease cyclically with the revolution of the counterweight; imperfect counterbalance increases the rail stresses greatly; aside from counterbalance effect, there is an increase of stress due to increase of speed, which in many instances amounts to half the static rail stress; such a speed effect is observed under the tender wheels as well as the engine wheels; the effect of the counterbalance may exceed the speed effect; the disturbance caused by counterbalance extends in some cases even to the leading and trailing wheels; the counterbalance effects are so important, and counterbalancing is so imperfect and uncertain, that the subject requires much more careful attention in locomotive design; in one locomotive the stresses under the left side were 20 per cent greater than those under the right; the lateral bending of the rail under the driving wheels is not related to counterweight position or to speed, and lateral bending moments ranging up to 8 per cent of the vertical bending moments were often found; the distribution of the locomotive loads to the ties and roadbed is the same as would be found on the assumption of uniform rail bearing; the bending of the ties shows that ordinary track is centerbound, while for a short time after tamping it is endbound; the greatest tie moment in a tie of first-class track is about 2.5W inch-pounds; the tie pressures distribute through the ballast in accordance with theory, and the ballast pressure is nearly uniform at a depth equal to the tie spacing.

Third Report—The third report, which is based on a

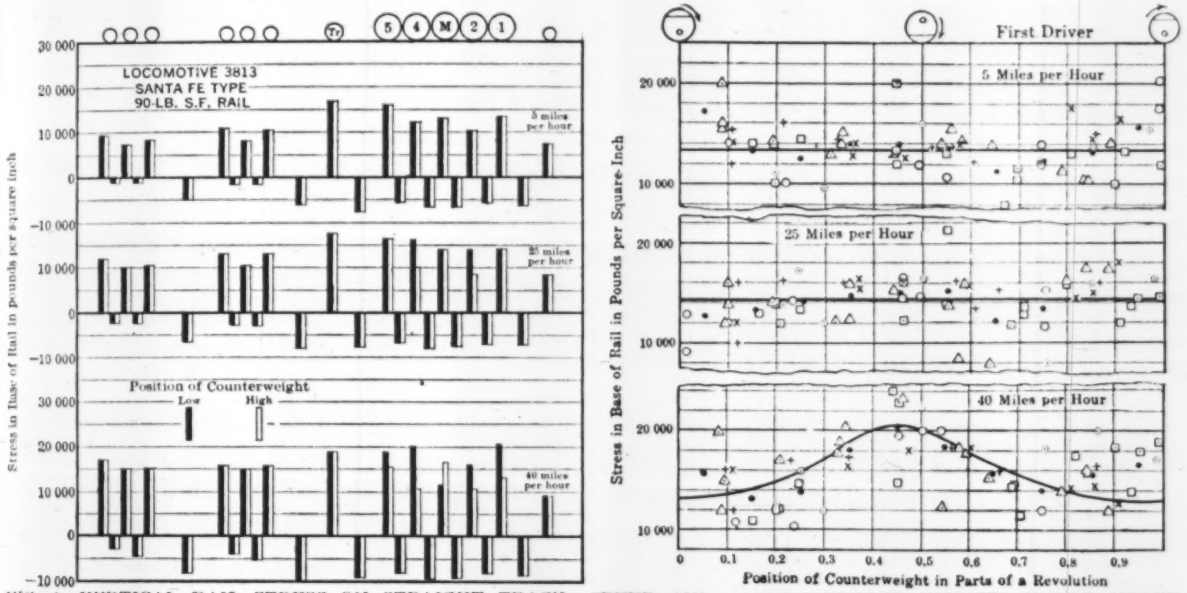


FIG. 1—VERTICAL RAIL STRESS ON STRAIGHT TRACK—SPEED AND COUNTERWEIGHT EFFECTS UNDER HEAVY SANTA FE TYPE LOCOMOTIVE

Left—Stresses under wheels at high and low positions of counterweight. Right—Stress variation under first driver during revolution.

greater number of measurements than the first and second combined, includes a new and more careful study of the vertical and lateral bending in straight track, especially with respect to speed and counterbalance effect, and a study of the corresponding actions in curved track of various degrees of curvature, under different locomotives, at speeds up to 60 m.p.h. In addition, a few measurements were made to determine the position assumed by a locomotive on a curve, and other measurements of the spreading of the track and the bending of the rails under a locomotive. Some of the major points brought out by this third report may be noted as follows:

1. No abnormal stresses are produced in the rail of straight track by locomotives with wheel loads of about 30,000 lb., except in case of a locomotive of decidedly rough-riding character.

2. Speed increases the stresses on straight track by 18 per cent at 40 m.p.h. and 27 per cent at 60 m.p.h. (in typical cases).

3. Counterbalance increases the rail stress about as much as speed does, provided the counterbalance is reasonably good.

4. Combined speed and counterbalance effect increases the rail stress by 30 to 53 per cent, but at one driver of a satisfactory locomotive the increase was 80 per cent and at one driver of a rough-riding locomotive the combined increase was 190 per cent.

5. The stresses under the two sides of the locomotive show only slight and variable differences.

6. The lateral bending stress in the rail on straight

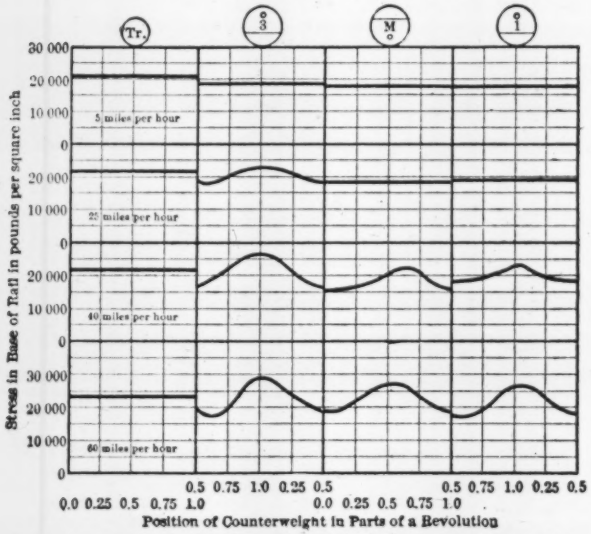


FIG. 2—SPEED AND COUNTERWEIGHT EFFECTS ON STRAIGHT TRACK

Curves of average rail stresses under wheels during one revolution, for drivers and trailer of Pacific type locomotive. The counterweight effect is represented by the variation in the ordinates of the curves. The difference between the mean values of the lower curves and the upper represents the speed effect.

track is frequently 33 per cent and in a few cases 50 per cent of the vertical bending stress but ordinarily the ratio did not exceed 10 per cent, with individual measurements varying 4,000 to 5,000 lb. per square inch from the average. The ratio of lateral to vertical bending appears to be independent of speed or counterbalance.

7. On curved track, friction on the rail head plays a part in developing lateral pressure on the rail.

TABLE I—SPEED AND COUNTERBALANCE EFFECTS FOR VARIOUS LOCOMOTIVES ON STRAIGHT TRACK

Principal values of per cent increase in vertical bending stress at the given speeds over the stress at 5 m.p.h. Lateral bending is not included.

Type of locomotive.	Drivers.				Trailer.	Tender Wheels	
	Speed Alone.		Combined Speed and Counterbalance.				
	General value.	Maximum under one driver.	General value.	Maximum under one driver.		General value.	Maximum under one wheel.
Atchison, Topeka and Santa Fe Railway: Pacific, 60 miles per hour	27	30	53	53	15	75	98
Balanced Compound Prairie type, 80 miles per hour	15	26	30	43	29	50	87
Mountain, 60 miles per hour	30, 30	30	35	50, 55	10	40, 60	110
Light Santa Fe, 45 miles per hour	40	77	105	190	10	93	95
Heavy Santa Fe, 40 miles per hour	18, 18, 18	28	50	80	15	75, 70, 50	110
Delaware, Lackawanna and Western Railroad: Pacific, 60 miles per hour	20	24	43	59	14	45	57

8. The distribution of load between the different drivers is greatly modified when the locomotive traverses a curve. The speed effect is about the same as on straight track, but the counterbalance effect is variable.

9. Large lateral bending stresses occur on curved track, these stresses being in many cases extremely high.

10. Very high combined stresses are likely to occur on curves, particularly because the high lateral bending is apt to occur under wheels giving abnormally high vertical bending. One reading of 75,000 lb. per square inch was recorded.

11. An intense and severe lateral bending action is exerted on the track as a whole while the locomotive passes around a curve, tending to distort and loosen the track.

12. On curves the gage of the track is spread by amounts which sometimes exceed ½ in.

Test Conditions—The tests were conducted at eleven different locations on four railroads, on straight track and on curves ranging in sharpness up to 10-deg., on profiles ranging from level to 1.40 per cent downgrade and 2 per cent upgrade. A large range of different kinds of track construction was represented. The rail ranged from 85 to 105 lb. in weight, the tie spacing from 18 to 22 in. Track with and without tie plates, and with plain and screw spikes, was represented. The ballast ranged from cinder to broken stone. Locomotives of seven different types were used—light and heavy Prairie type (2-6-2), Pacific (4-6-2), Mikado (2-8-2), Mountain (4-8-2), light and heavy Santa Fe types (2-10-2), and a Santa Fe with four-wheel trailer truck (2-10-4). The driver loads ranged from 25,000 to 33,000 lb. per wheel.

The main tests, in which rail stresses were measured, were carried out with the use of the stremmatograph, described in connection with the first report. This is an extensometer of 4-in. gage length, in which the lengthening or shortening is recorded without magnification by a fine metal point bearing on a smoked glass disk rotated by a hand-driven gear. Generally eight instruments were used, four on each rail, with the result that the measurements were very much more comprehensive than in the earlier tests, in which four were used. Each instrument carried two disks, recording separately the stresses at inner and outer edge of the rail base.

Most of the tests were made with the engine coasting, but in a few tests loads were hauled; no particular

effect of the drawbar pull upon the rail stress could be found.

All measurements of stress from the records were corrected for the distance of the stremmatograph bar below the rail base, and for the variation of stress within the gage length, so that the figures finally reported represent the stress in the middle of the rail base at the point directly under the wheel. A total of 470,000 microscope readings of records was required in reducing the results, and the work extended over three years; a skilled observer could make 1,000 to 1,200 readings per day.

Straight Track—Vertical bending effects in rail as found from the measurements on straight track are typically represented in Figs. 1 and 2 herewith. The stresses are averages, usually some 50 to 125 observations being averaged to give a single figure. Variations of 5,000 lb. per square inch above and below these averages occur. At slow speed the measured values agree very well with those calculated by the theory previously developed (see first report), using 1,600 lb. per lin.in., of rail as the value of the modulus of elasticity of rail support (determined for these particular tests by special measurements).

TABLE II—RATIO OF STRESS AT OUTER EDGE TO MEAN STRESS IN BASE OF RAIL

General values of average ratio, for wheels of several locomotives.

Locomotive.	Speed, in miles per hour.	Average of tender wheels.	Trailer.	Driver Number. 5	4	3	2	1	Front truck wheels.
Atchison, Topeka and Santa Fe Railway:									
Pacific	5	1.08	1.05	.....	.....	1.17	1.14	1.12	1.08 1.01
	25	1.06	1.04	.....	.....	1.14	1.12	1.12	0.96 1.05
	40	1.08	1.07	.....	.....	1.08	1.10	1.12	1.06 1.05
	60	0.99	1.07	.....	.....	1.08	1.13	1.17	1.08 1.01
Light Santa Fe	5	1.00	0.98	1.10	1.10	1.01	1.08	1.25	1.05
	25	1.01	0.97	0.99	1.06	1.05	1.09	1.31	1.04
	35	1.00	0.99	0.96	1.09	1.05	1.24	1.31	1.00
	45	1.04	0.94	1.00	1.02	1.07	1.27	1.20	1.04
Heavy Santa Fe	5	1.18	1.08	1.06	1.18	0.97	1.16	1.12	1.01
	25	1.07	1.01	1.05	1.15	0.98	1.10	1.06	0.97
	40	1.00	1.05	1.09	1.13	0.89	1.10	1.06	0.97
Double Trailer, Heavy Santa Fe	5	1.08	1.02 0.98	0.96	0.98	0.97	1.00	1.05	0.97
	25	1.05	1.04 1.01	0.97	0.98	0.94	1.01	1.01	0.96
	40	1.05	1.05 1.05	1.08	1.05	0.99	1.05	1.07	1.04
Delaware, Lackawanna and Western Railroad:									
Mikado	5	1.06	1.00	.....	1.06	1.14	1.24	1.17	1.20
	15	1.05	0.96	.....	1.04	1.18	1.31	1.15	1.14
	28	1.04	1.01	.....	1.07	1.18	1.28	1.13	1.18

Counterbalance effects are not perceptible at the speed of 5 m.p.h., but at greater speeds the plotted points when averaged in narrow groups form a distinct wave-like curve (see right-hand diagram in Fig. 1), so that the rail stress under different wheels may be plotted on fractions of the driver revolution as abscissas, as in Fig. 2. The average for the full revolution, taken as the mean stress under the wheel for that particular speed, is greater than the stress at a speed of 5 m.p.h., this excess representing the speed effect. The difference between the high or the low point of the wave-like curve and its mean is the counterbalance effect. The counterbalance effect differs considerably in the different locomotives, and, just as in measurements previously reported, some of the locomotives appear to be very badly counterbalanced. However, the counterbalance stresses are reported as being "not unreasonably high" except in one locomotive (Light Santa Fe type).

Speed effect (see Table I) was found to average from 15 to 27 per cent, except for a considerably higher value in the Light Santa Fe. Except for two engines, the maximum speed effect under any one driver is reported as generally less than 35 per cent.

Combined speed and counterbalance effect ranged from 30 to 53 per cent, and the maximum under any

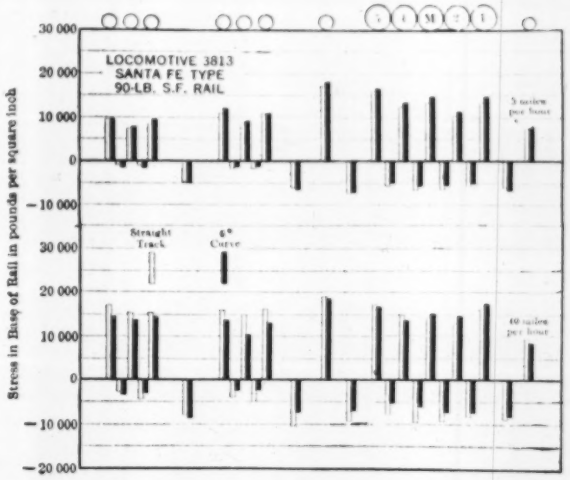


FIG. 3—TOTAL VERTICAL EFFECT ON CURVE SAME AS ON STRAIGHT TRACK

Black bars, average of stress in inner and outer rail on 6° curve. White bars, rail stress on straight track. Both are for a locomotive of Heavy Santa Fe type, on 90-lb. rail, at speeds of 5 and 40 m.p.h. The stresses are those in the middle of the rail base.

driver from 43 to 80 per cent. The maximum stress in the rail ranged from 20,000 to 29,000 lb. per square inch; this figure disregards the variation of individual observations from the averages, and also does not include the effect of lateral bending, or the excess of stress in the outer or inner edge of rail base from the mean.

In the Light Santa Fe type locomotive the combined speed and counterbalance effect under the several drivers was 87, 74, 190, 97, and 73 per cent respectively. As found later, the lateral bending produced by this locomotive is also high.

The trailer showed no counterbalance effect (such an effect was noted in the second report), but its speed effect was about the same as that of the drivers. The speed effect of the tender was generally larger than that of the drivers, ranging from 40 to 75 per cent.

Summarizing, the report says that, except for the Light Santa Fe type, no abnormal vertical stresses were found at any speed. The wheel loads being closely alike, the stresses found under the drivers do not differ greatly (allowing for differences in rail weight), except in one or two cases where the division of load apparently differs from the nominal division. The speed effects, 18 per cent at 40 m.p.h. and 27 per cent at 60 m.p.h., are regarded as moderate. The counterbalance effect is reported as about the same as the speed effect; however, it is generally much greater under some one driver, and more careful study of the counterbalancing problem seems desirable. In all the locomotives tested, the conditions of counterbalance in the main driver differed considerably from that assumed in the design.

As the average stresses under all the wheels checked closely with the average of the stresses calculated from the previously developed theory, the theory is considered to be further confirmed.

A special comparison of the stresses under the left and the right sides of the locomotive showed no particular difference.

Lateral Bending on Straight Track—From the ratio of the stress at one edge of the rail base to the mean stress in the rail base it was found that the lateral bending stress is frequently 33 per cent or more of the

vertical bending, in a few cases reaching 50 per cent. The lateral bending stresses plot in a belt having a width of 4,000 to 5,000 lb. per square inch either side of the mean curve. The average lateral stress percentages for different locomotives under different wheels usually remained below 10 per cent, but under the first two drivers of the Light Santa Fe the average percentages ranged from 20 to 33. The report says:

"For a ratio of stress at the outside edge to mean stress with a value of 1.33, it is seen that the lateral bending moment in rail is about 7 per cent of the vertical bending moment required to develop the mean stress in the base of rail. A value of the lateral bending moment found quite frequently is 4 per cent of the vertical bending moment, although in a few cases it reached 14 per cent, if the effect of the added 5,000 lb. per square inch of the belt of stresses is taken into consideration. From a study of the observed values, it would seem that in designing a rail section for straight track a lateral bending moment at least equal to 14 per cent of the vertical bending moment should be provided for."

The ratio of lateral to vertical bending stress seems to be independent of speed and of position of counterweight.

Curved Track—While the tests on curved track gave in many respects more variable results that those on straight track, their accuracy is well shown by a comparison of the total vertical effect (average of stress in the base of inner and outer rail) with the rail stress on straight track. Fig. 3 shows that the results are substantially identical. It is to be remembered that lateral bending effects are eliminated in this diagram, as the plotted values represent the stress in the middle of the rail base.

The large lateral bending effects on curves, and their essential difference for the inner and outer rail, are represented typically by the two diagrams in Fig. 4, taken under a locomotive of Santa Fe type on 10-deg. curve, at slow speed and at fairly high speed. The change in distribution of lateral pressure with speed is obvious. The high pressure of the fourth driver against the inner rail at low speed and the high pressure of the first driver against the outer rail at high speed are particularly noticeable.

It is reported that in the observations the body of the observed values lay in a belt that was frequently within 6,000 lb. per square inch of stress of the line of average stress, although in some cases the range was much wider; generally it may be assumed that the average stresses are representative of the actual phenomena, but that a range of stress above and below the average line amounting to 4,000 to 12,000 lb. per square inch occurs.

The change of lateral bending with speed is represented by direct plotting in Fig. 5, which represents stresses under a Mikado locomotive on 6-deg. curve. The principal change evidently is concentrated at certain of the wheels.

Specific figures for lateral bending stress (averages for many observations) are given in the lower diagram in Fig. 6, which represents the stresses produced by a locomotive of Mountain type on 6-deg. curve. Other lateral effects on the same curve with the same locomotive are shown in the upper and middle diagrams of the same figure, showing for a standing locomotive the position of the wheel flanges with respect to the rail and the distortion of the track, or the amount by which the rails have been forced away from their unloaded position. The amounts of displacement are given in inches, and they have been drawn to a highly exaggerated scale, but it may be seen that the track is very seriously distorted. No such measurements were made under a running locomotive, but from the change of

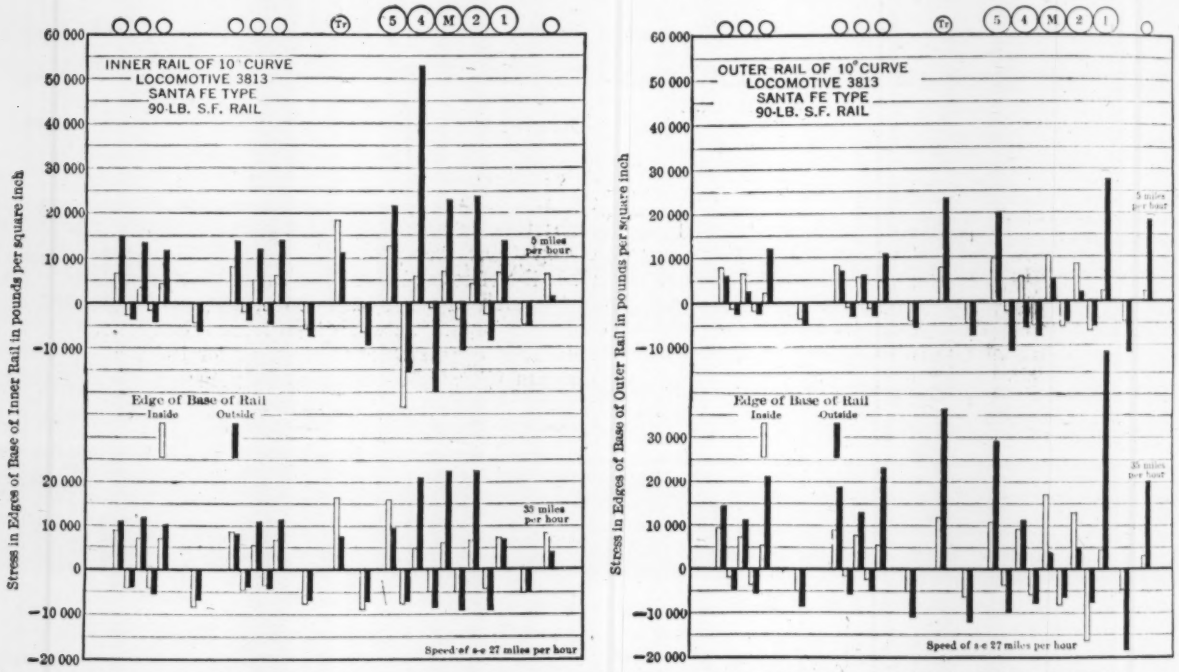

INNER RAIL OF 10° CURVE
LOCOMOTIVE 3813
SANTA FE TYPE
90-LB. S.F. RAIL
OUTER RAIL OF 10° CURVE
LOCOMOTIVE 3813
SANTA FE TYPE
90-LB. S.F. RAIL
Edge of Base of Rail
Inside
Outside
5 miles per hour
35 miles per hour
Speed of 5 e 27 miles per hour
Stress in Edges of Base of Inner Rail in pounds per square inch
Stress in Edges of Base of Outer Rail in pounds per square inch

FIG. 4—LATERAL BENDING STRESSES IN RAILS UNDER A STIFF LOCOMOTIVE ON A SHARP CURVE
Comparison of stresses at inner and outer edges of rail base on 10° curve under a locomotive of Heavy Santa Fe type, running on 90-lb. rail, at low speed and at high speed.

lateral bending stresses with speed it may be presumed that the distortions would be different at speed.

Some of the points brought out in the report with respect to the lateral bending stresses are: In locomotives with two-wheel front trucks, the lateral bending of the outer rail at the outer front driver is positive at all speeds, but in the case of four-wheel leading trucks this pressure is usually negative (directed toward the center of the curve) at low speed and tends to become positive at higher speeds. The outer rear driver produces outward thrust at all speeds, except in one locomotive. The other drivers generally give negative bending (tending to straighten the rail) at low speeds, with a tendency toward positive bending at increased speeds. The trailer has an outward thrust against the outer rail in all cases at the higher speeds, but its action against the inner rail varies.

These lateral bending stresses "are of considerable magnitude, in many cases extremely high." Under the fourth driver of a Santa Fe locomotive on the inner rail of a 10-deg. curve lateral bending of 23,500 lb. per square inch was found at low speed, in another similar test 25,800, and in a third 20,300. An outer front driver of another locomotive at high speed produced lateral bending on the outer rail of 22,600 lb. per square inch. The third driver of another locomotive produced lateral bending of the inner rail of 19,800 lb. per square inch on 10-deg. curve at 5 miles per hour. Other values scale downward from these figures.

"When the stress due to lateral bending is combined with that due to vertical bending, it will be seen that the resulting stress may be very great. This is the more marked because the high lateral bending stresses generally occur under wheels giving very high vertical bending stresses, much greater than those developed on straight track. Thus, for example, at the outside edge of the base of the inner rail of the 10-deg. curve under the fourth driver of the Santa Fe type locomotive at 5 m.p.h., the stress is the sum of 23,500 and 29,200, resulting in a stress of 52,700 lb. per square inch. This value is the average of a large number of runs; not infrequently stresses several thousand pounds greater than this were found, indeed one of 75,000 lb. per square inch was recorded. It may be added that the value of the lateral bending stresses under many of the wheels ranged from 40 to 100 per cent of the vertical bending stress under the same wheel."

The lateral bending moments for the two rails, and also for the two rails combined, that is, for the track as a whole, were also studied, producing such diagrams as reproduced in Fig. 7. The lower diagram, showing the combined bending moment (on the track as a whole) is particularly important. It shows "the intense and severe lateral bending action which comes on the track as a whole as the locomotive passes around the curve, tending to push the ties and ballast first to one side and then to another and to throw the curve out of line."

The ratio of the lateral bending moment to the vertical bending moment at the same point of the rail reached an average value of 0.16, as compared with an average value of 0.04 on straight track.

Vertical Effects on Curves—The division of load between the two rails was found to be very closely that computed from the lateral inclination of the track and the centrifugal force, when the average of all the wheels on one side was compared with that on the other. However, the distribution of load between the several wheels on one side is quite different from that found on straight track or to be expected from the functioning of the equalizer system. "At 5 m.p.h. the vertical bending stresses in the inner rail of the 6-deg. curve under the third and fourth drivers of a heavy Santa Fe locomotive are far higher than are to be expected from considerations of transverse inclination of track and

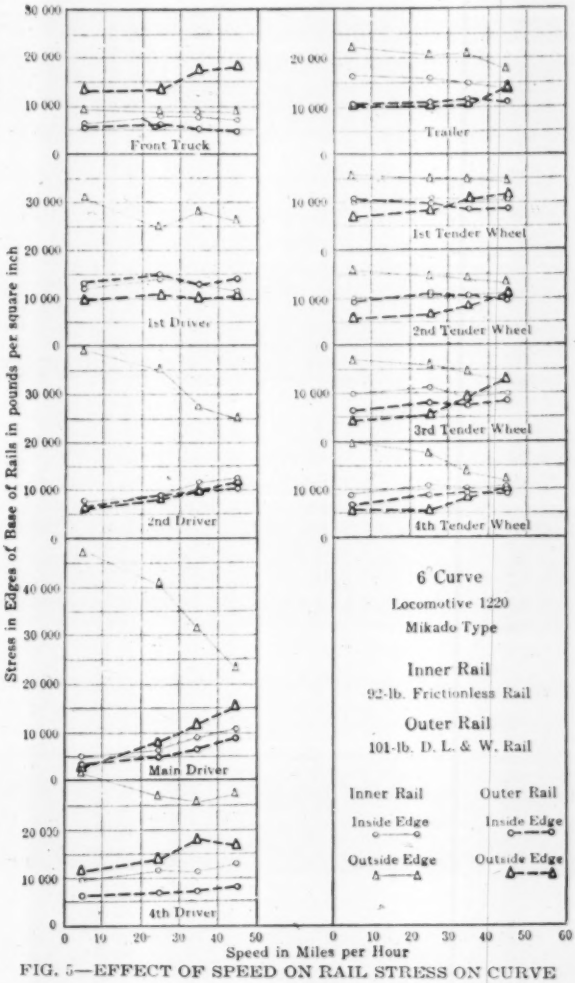


FIG. 5—EFFECT OF SPEED ON RAIL STRESS ON CURVE

centrifugal force. The loads transmitted from these inner drivers, estimated from the observed vertical bending stresses, are 47,000 and 46,000 lb., 50 per cent greater than the nominal load. On the 10-deg. curve at Ribera, at 5 m.p.h., the load transmitted to the inner rail by the fourth driver is estimated to be 64,000 lb., more than twice the normal load. In the Mountain type locomotive, the vertical bending stresses in the inner rail of the 6-deg. curve under the second and third drivers at a speed of 5 m.p.h. are 2½ and 2¼ times those in the outer rail. This means loads of 44,000 and 42,000 lb., 40 per cent more than the normal load on straight track—far more than will be produced by transverse inclination of track alone. On the 10-deg. curve, the corresponding vertical bending stress in the inner rail under the second driver is nearly three times as great as that in the outer rail, and under the third driver five times as great. This means loads of 45,000 and 53,000 lb., 50 per cent more than on straight track for

the second driver and 75 per cent for the third driver, the latter driver thus giving a very high bearing pressure on the rail."

Again, "These excessive loads produce high stresses in the rail, but more important still they give very high bearing pressures on the rail. It is a well known fact, of course, that the inner rail of curves suffers greatly from the high pressure on it. The bearing pressures on the rail on straight track constitute a serious problem, and the conditions on the curves seem to be far worse that they have been thought to be. As the bearing pressures found are considerably higher under some of the wheels than those which ordinary analysis of the effect of transverse inclination of track and centrifugal force would predict, it would seem well to have a study made of the action of the equalizing levers and the springs on curved track to try to find the cause of the concentration of load, and to attempt to modify the design so as to obviate such gross inequalities."

The effect of counterbalance on the rail stresses proved to be much more variable on curved than on straight track. "In estimating the stress that will include the effect of counterbalance, the best that can be done is to take the average stress throughout the revolution of the driver and then allow for a very much greater variation in the stress above and below this line than would be done for straight track."

Effect of Locomotive Type—When straight track alone is considered, "variations in the design of locomotive, such as the length of wheel base, the number of drivers, the use of two-wheel or four-wheel trucks, may be made without bringing unduly high stresses into the rail." On curves, there are marked differences between the actions of two-wheel and four-wheel leading trucks, and the unexpected effect of greatly increased

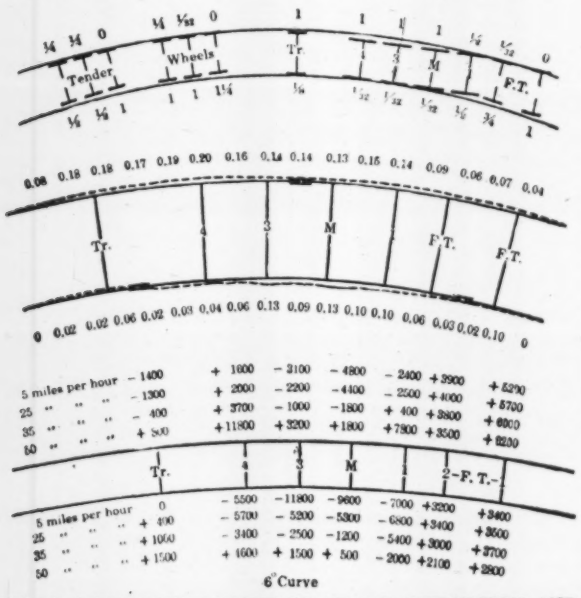


FIG. 6—LOCOMOTIVE POSITION, TRACK DISTORTION AND LATERAL RAIL STRESS ON CURVE

Mountain type locomotive on 6° curve with 4.7 in. superelevation.
Upper diagram shows position of wheels (not to scale), with figures giving distances of flanges from rails, in inches, under the standing locomotive.
Middle diagram shows in exaggerated plotting the distortion of the track under the standing locomotive, the figures giving the displacement of the rail from unloaded position, in inches.
Lower diagram gives the lateral bending stresses in the rail base at speeds of 5 to 50 m.p.h.; positive values represent a tendency to increase the curvature.

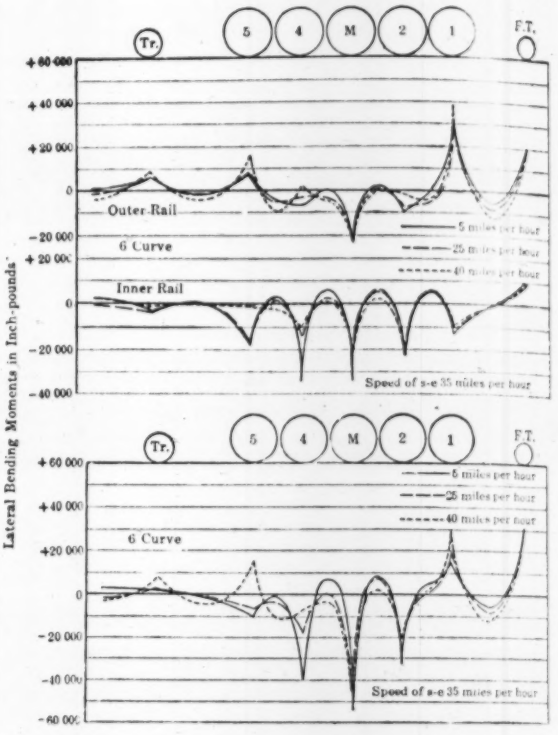


FIG. 7—LATERAL RAIL BENDING AND TRACK BENDING

Upper diagrams show lateral bending moments in outer and inner rail of 6° curve under locomotive of Heavy Santa Fe type.
Lower diagram shows combined lateral bending moments (algebraic sum of the above) on the same curve.

load on the inner rail under one or more of the drivers, as well as the strong lateral spreading action on the inner rail, bear directly on locomotive design.

The four-wheel leading truck of the Pacific and Mountain types was found to have distinct advantages over the two-wheel truck of the Santa Fe and Mikado types, the former giving moderate vertical bending as well as moderate lateral bending, and relieving the first outer driving wheel of guiding action, while with the two-wheel truck the lateral bending stress under the first outer driver was often great or even excessive. As to four-wheel vs. two-wheel trailing truck, the one locomotive with four-wheel trailer had a changed distribution of load on the other wheels, so that the value of the arrangement could not be judged fairly.

Wet rail modifies the stress distribution somewhat.

Bending of Rail Sections—By means of a special instrument, which could be fastened to the rail base and measured the lateral deflection of the head of the rail with respect to the base, the transverse bending of the rail section was determined in several tests. The deflection ranged up to 0.016 in., being greater on 10-deg. than on 6-deg. curve.

The Special Committee to Report on Stresses in Railroad Track is headed by Prof. Arthur N. Talbot, of the University of Illinois, Urbana. It is a joint committee of the American Society of Civil Engineers, the American Railway Engineering Association, and the American Railway Association, and has been at work since 1914. The third report, summarized in the preceding, was presented before the American Society of Civil Engineers at its annual meeting in January, and is to be presented to the American Railway Engineering Association at its meeting on March 14.

How the Johnstown Water Company Met the Recent Drought

Industrial Supply of Steel Company Drawn On and Chlorinated Under Unusual Conditions—Public Advised to Boil Water

As a result of the severe drought in Pennsylvania in the latter part of 1922 the City of Johnstown was compelled to resort to an emergency water supply. Besides requiring chlorination and other precautionary methods this gave rise to a hydraulic problem, all as described below through the co-operation of Charles W. Kunkle, superintendent of the Johnstown Water Company.

Johnstown is an industrial city of some 75,000 population. Its water supply is furnished by the Johnstown Water Co., from impounding reservoirs having a combined capacity of 1.14 billion gallons. The extensive works of the Cambria Steel Co., in and near Johnstown, have an independent water supply for industrial purposes only, which was pressed into service for the domestic supply of Johnstown during the flood. Like the city supply, that of the steel company is drawn from impounding reservoirs, one on Hinckston Run and one on a tributary of Stony Creek. The latter is known as Quemahoning reservoir, has a capacity of about 11 billion gallons and is the largest artificial body of water in the State of Pennsylvania.

Auxiliary Supplies Attained—In September, 1922, because of the rapid depletion of the supplies normally used the Johnstown Water Co. found it necessary to obtain an auxiliary supply and this was secured from the Hinckston Run system of the Manufacturers' Water Co., which company is controlled by the Cambria Steel Co. Application for the use of this supply was made to the Pennsylvania Department of Health on Sept. 25, and approval of the project being granted, the supply from Hinckston Run reservoir was turned into a portion of the system in the western part of the city on Sept. 28. The water was chlorinated.

At the same time an appeal was made to consumers to conserve the use of water in every way, this merely emphasizing a notice to that effect made previously.

Some relief was experienced by the use of the Hinckston Run supply but the drought continuing it was discovered that an additional auxiliary supply would be necessary and accordingly on Nov. 27 the Johnstown Water Co. requested permission to avail itself of the supply from the Quemahoning reservoir, already mentioned as an industrial supply—which under normal conditions is not chlorinated. There are several interesting features in connection with the use of the Quemahoning supply.

The supply main from this reservoir is 66 in. in diameter and at the point where the connection was made the pressure is about 110 lb. It was proposed to connect from the Quemahoning line to a 10-in. main of the Johnstown Water Co., ordinarily used as a distributing main on a pumping system. Consequently the problem presented was to effect the introduction of the Quemahoning water into the distributing system and to so control the pressure in the distributing system as to satisfactorily serve the water to consumers and at the same time enable the water company to introduce chlorine gas into the supply.

Hydraulic and Chlorination Control—About 200 ft. of 12-in. connecting pipe line was laid from a 6-in. air valve on the Quemahoning pipe line. The necessary valves were installed for the control of the water and the 10-in. distributing main, which became a supply main, was tapped at such an elevation as to bring some 20 to 25 lb. back pressure on the chlorine machine, which was installed in a small temporary building at a street intersection. In the same building a pitometer was connected with the 10-in. main in order to measure the amount of water supplied from the Quemahoning line into the distributing system and also to enable the operator of the chlorine machine to so manipulate his valves as to keep the pressures in the right relation in order that the chlorine gas machine would properly function.

The flow of water after chlorination was directed in a round-about way in order that the longest practicable period of contact between the germicide and the water might be obtained before it reached the consumers.

Coincident with the introduction of the Quemahoning supply the Johnstown Water Co. spread broadcast throughout the entire city notices advising the public of the necessity of boiling all water used for domestic purposes, calling attention to the fact that the supplies were depleted and the water levels in the reservoirs had been drawn down to a point near the bottom and that consequently the beneficial effect of sedimentation in the reservoirs was practically nullified.

The arrangement for handling the Quemahoning supply proved to be entirely satisfactory and capable of quite delicate control. This supply was cut off from the system on Dec. 18, 1922. In addition, to making the daily analyses of the water furnished its patrons in the city tests for residual chlorine with orthotolidin were made at frequent intervals to determine the efficiency with which the chlorine apparatus was working.

The notice advising the public to boil water was issued by the water company on its own volition but with the knowledge of the local health officials and of the State Department of Health. After the emergency supplies were discontinued the water company flushed the system and when the results of the bacteriological analyses of the supply indicated the water to be free from sewage organisms the State Department of Health advised the water company and the local officials that the "boil water" notices could be withdrawn.

During the entire period the closest co-operation was had between the water company and the local health officials as well as with the State Department of Health. It is significant also that the public assisted in the efforts of the water company to handle a serious situation. This demonstrates the advisability of frankness on the part of a public utility with the public in meeting emergencies of this sort.

Cape-To-Congo Railway Service

Through trains between Cape Town, South Africa, and Bukama, at the head of navigation on the Congo, are being run twice a week. The distance of 2,700 miles is covered in about seven days, of which two days are spent at Bulawayo and Elizabethville (capital of Katanga) for the convenience of tourists. The route includes the South African Government Railways to Bulawayo, the Rhodesian Railways to Sakania, and the Katanga Railway (through Belgian Congo) to Bukama.

New Floor Design Reduces Load in Tall Steel Building

Increased Weight Due to Additional Stories Is Compensated by Adopting Floor Design of Lighter Weight

A CHANGE to a lighter type of floor construction for a large partly-finished steel-frame building at Kansas City, Mo., has been made necessary by the decision to build additional stories and thus add to the weight to be carried by the structural work already erected. The steel frame for the 19-story Kansas City Athletic Club building was erected about three years ago, but work was then stopped on account of financial difficulties. When the project was revived and financed recently, it was decided to complete the building substantially according to the original plans, but to increase the height to twenty-one stories and a roof garden.

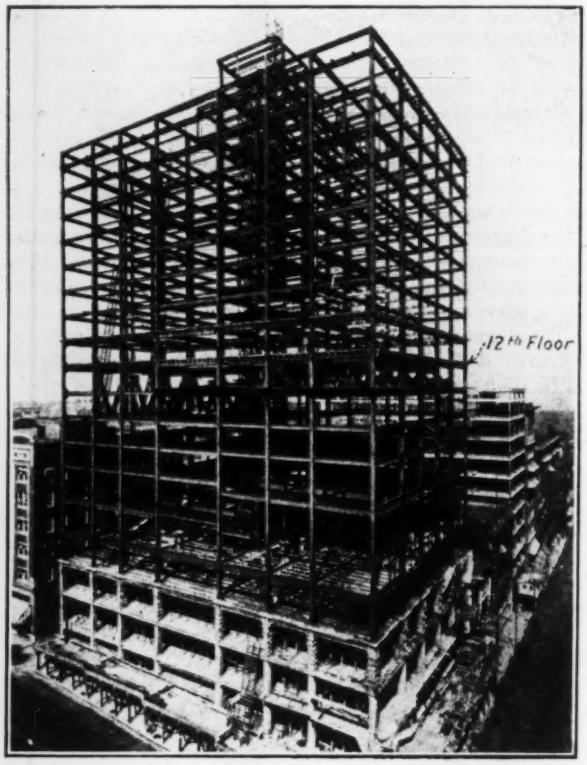


FIG. 1—KANSAS CITY ATHLETIC CLUB BUILDING
Two stories added to 19-story structure. Light floor construction used in upper floors. Steel trusses carry upper stories over open spaces.

To explain the redesign of the floors some description of the steel design is necessary. Steel trusses having their upper and lower chords in the eleventh and twelfth floors carry the east 56 ft. of the building (three panels) above the eleventh floor across the gymnasium. Similar but deeper trusses, having their chords in the tenth and twelfth floors, carry the west 56 ft. of the building over the swimming pool. These latter trusses are located in the partitions between the handball courts. In the original design all the floors were to be of ribbed concrete slabs, and this construction is used up to and including the level of the bottom chords of the trusses in both ends of the building.

In checking the design to provide for two additional stories it was found that the columns would sustain the load due to floors of the original ribbed slab design in the new stories, but that the trusses would require reinforcement. In order to avoid such reinforce-

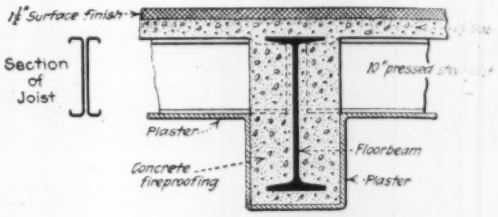


FIG. 2—LIGHT-WEIGHT FLOOR CONSTRUCTION

ment, it was decided to use a lighter floor construction, consisting of a 2½-in. reinforced slab carried on pressed-steel joists fitted between the original floor beams. Beginning this new floor design in the twelfth floor, the resultant reduction in dead load of the eight floors proved to be sufficient to compensate for the additional load of the twentieth and twenty-first floors. In this way the total load on the trusses was increased so slightly that no alterations in the steelwork were required. The original ribbed slab design is being adhered to for the main roof, the roof garden and the pent-house construction, as well as for the first eleven floors.

Typical panels are 19½ x 20½ ft. and 19½ x 18 ft., with the new joists in the 19½-ft. spans and spaced 20 to 24 in. c. to c. according to the width of the panel. These are standard 10 in. pressed-steel joists, made of pairs of light pressed-steel channels set back to back and spot-welded together so as to form an I-section (see *Engineering News-Record*, Aug. 17, 1922, p. 269). Over the floor-beams and the joists is a 2½-in. concrete slab with a 1½-in. surface finish.

Special construction was required for the support of the new joists, since the original construction had no provision for such members. To attach brackets or shelf angles in the field, necessitating the drilling of rivet holes in all floor beams, would have been impracticable and would have resulted in additional weight. The plan adopted was to build the lower part of the concrete casing or fireproofing of the floor beams so as to form a shelf for the 10-in. joists, the ends of the joists being embedded in this casing, which is reinforced with wire-mesh fabric. This floor construction is shown in Fig. 2. Wood forms for the combined shelf and beam casing were suspended from the floor beams, as shown in Fig. 3. While this concrete was being placed the joists were supported by falsework, which was kept in place for at least one day after the concrete was poured.

The relative fire resistance of the new type of floor, as compared with the heavier reinforced-concrete construction, in the event of a great conflagration, was taken into consideration in view of the fire in the Burlington Building at Chicago in March, 1922. But the owners of the Athletic Club Building considered the additional two stories to be of sufficient importance to justify the change in construction. For fireproofing the truss members a solid reinforced-concrete casing is to be applied.

Live-loads in general are 50 lb. per square foot, but there are a few exceptions in special locations; a load of 40 lb. was assumed for the roof, 75 lb. for the roof garden, 90 lb. for the main dining room, kitchen and

gymnasium, and 300 lb. for the sidewalks. In addition to these live loads on floors an allowance of 20 lb. per square foot was made to provide for partitions.

For the original design as well as the present altered

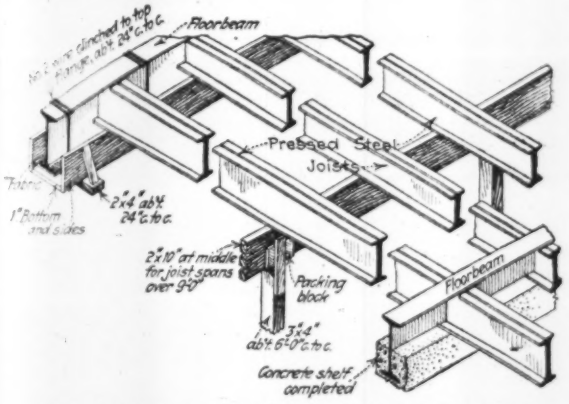


FIG. 3—CONCRETE SHELVES SUPPORT NEW JOISTS

design of the building the architects were Hoit, Prince & Barnes, of Kansas City. The Swenson Construction Co., also of Kansas City, is the general contractor. The original structural framing and its present additions were designed and erected by the Kansas City Structural Steel Co., but the pressed-steel joists were furnished by the Central Steel Co., Massillon, Ohio. The combined club and office building is now owned by the Continental Building Co.

Railway Terminal Station Plans for Chicago

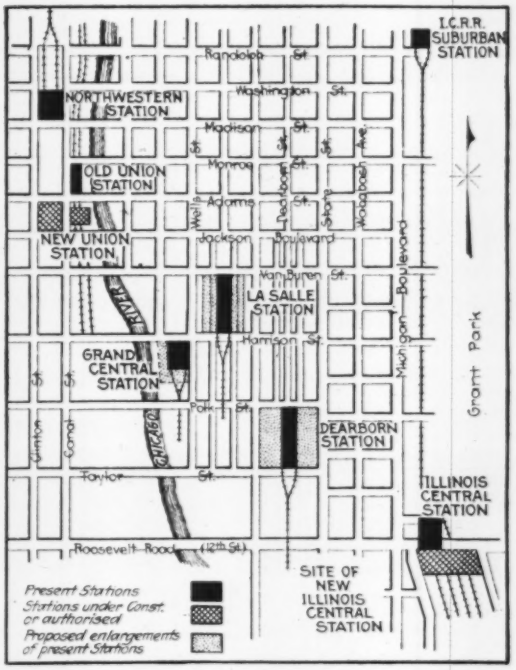
A SOMEWHAT confused situation in the Chicago railway terminal problem has been brought about by the preparation of varied and conflicting projects for new passenger stations, so that there is now a combination of existing, authorised and proposed stations of modern type and large capacity. The situation will be explained by reference to the accompanying plan. There are now six terminal stations and independent projects are on foot for the reconstruction of three of these stations. Confusion arises from the fact that some of these projects propose the elimination of other stations by providing accommodation for the tenant roads of the latter. Whether any combination of the various groups can or will be effected remains to be seen.

Of the present six stations, the Northwestern Station of the Chicago & Northwestern Ry., opened in 1911, was the first of the modern stations. It is the only one of the terminals used by a single railway and is notable as being new both as to location and construction. All other projects provide for reconstruction on existing sites, suitably enlarged, to accommodate present or prospective groups of railways. The ancient Union Station is now being replaced by a large modern structure with greatly increased trackage and other facilities for a group of railways. Plans have been authorised for the reconstruction of the Illinois Central Station on a large scale, and it has been suggested that this new station might be utilized by some of the railways now entering other stations.

This leaves the Dearborn Station, La Salle Station and Grand Central Station to be considered. All of these serve groups of railways. The second is comparatively modern and has an office building over the headhouse, but the others are old and the last named is the smallest of the Chicago terminal stations.

Now comes the question of reducing the number of stations. It has been suggested that many or all of the roads now using these three stations might be accommodated in the enlarged Union Station and Illinois Central Station, thus releasing valuable property sites and concentrating the terminal facilities. But plans have already been prepared for a new and enlarged Dearborn Station, and this project includes the suggestion that the roads now using the La Salle Station might be accommodated with mutual advantage. This project is offset, however, by independent projects reported for the reconstruction of the La Salle Station and the Grand Central Station.

Possibilities of earlier projects for a single great passenger station to accommodate all the numerous railways



PRESENT AND PROPOSED CHICAGO TERMINALS
Northwestern Station is modern. Union Station is being rebuilt. Illinois Central Station reconstruction is authorized. Independent projects propose reconstruction of Dearborn, La Salle and Grand Central stations.

have long ago disappeared, owing to the establishment of some modern individual stations and to the impossibility of uniting all the various interests upon the acceptance of one site and one plan. Probably this is well for Chicago and the traveling public, since the practicability of efficient operation of a station serving about twenty-four railroads has been questioned. All these roads have approximately the same concentration of heavy inbound main-line traffic in the early morning and heavy outbound traffic in the evening, so that the station facilities would have to provide for these two peaks of service. In addition, some of these roads have very heavy suburban service. However that may be, or might have been, projects of this class are no longer a practical factor in the problem, but the developments in the present terminal situation may be watched with interest on account of the civic and economic aspects as well as the railway and engineering aspects.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Submarine Cutting Torch Used in Bridgework

By C. P. Howes
Bridge Engineer, Texas & Pacific Ry., Dallas, Texas

AFTER VARIOUS means had been discussed for the removal of obstructive sheet piles in the channel of the Atchafalaya River, Melville, La., use of a submarine cutting torch was decided upon. The same system of cutting was applied as was used last year in the repair of a 36-in. pipe line which carries the New York City water supply from Brooklyn to Staten Island. (See *Engineering News-Record*, March 2, 1922, p. 346). Thirty steel sheet piles at depths under water ranging from 15 to 25 ft. were cut off with the electric torch. Necessity for removing the piles was due to their having been bent when, during the unprecedented flood of last spring, a huge timber fender pier containing about 120,000 ft.b.m. of timber was torn loose from a bridge forty miles upstream and in passing the Atchafalaya Bridge struck the end of a sheet-pile cofferdam, which had been installed as pier reinforcement, shattering the concrete filling and tearing a portion of the cofferdam loose. Though the integrity of the pier as a support for the bridge was not affected, the immediate removal of the bent sheet piles was important as they encroached

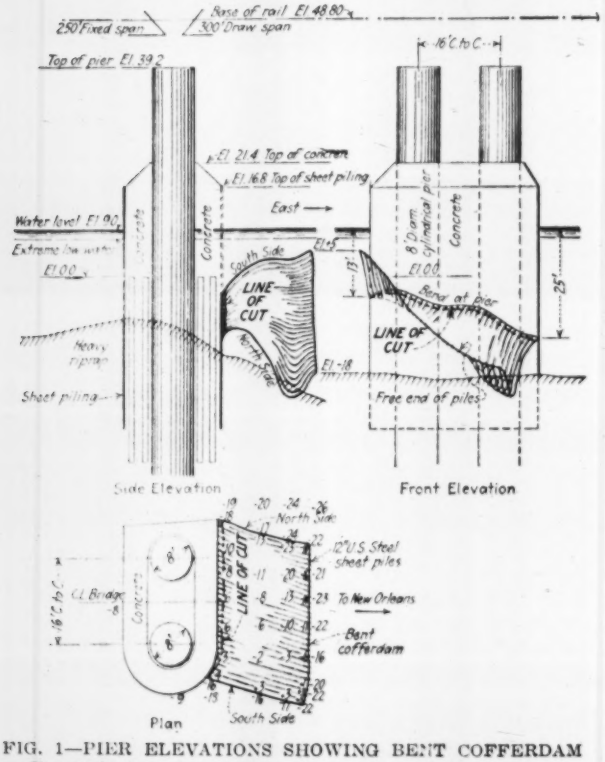


FIG. 1—PIER ELEVATIONS SHOWING BENT COFFERDAM
Removal of the bent cofferdam was necessary as obstruction to river transport was offered at low-water level. Position of the sheet piles before and after the pier was damaged is easily indicated.

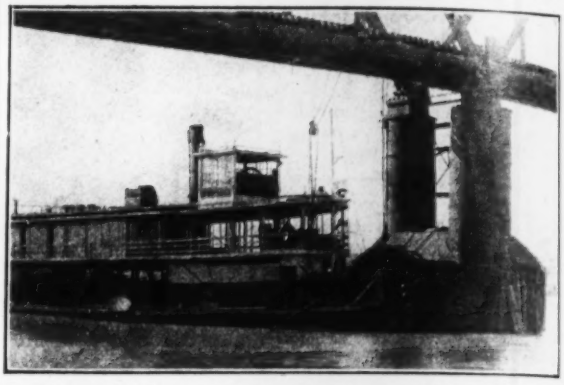


FIG. 2—DIVER DESCENDING FOR CUTTING WORK

on the west navigable channel opening of the bridge and obstructed free navigation in low stages of the river.

Each of the piers under the fixed spans of the bridge, (which was built in the early eighties) consists of two metal cylinders 8 ft. in diameter, filled with concrete, and extending about 80 ft. below the river bed. The supporting strength of these piers had never been questioned, but with the increase in rolling stock weights, timber piles were driven around the cylinders and a cofferdam constructed of 12-in. steel sheet piles, 45 ft. long, inclosing the timber piles to act as forms for concrete. Such reinforcement was deemed advisable, in order to reduce the flexibility of the piers. The sheet piles had a penetration of about 20 ft.

When it was found necessary to remove the sheet piles it was deemed impractical to pull them, either singly or collectively, because of their distorted condition. Other methods, not involving what appeared prohibitive expense, were discarded because of uncertainty as to effective results. The use of the underwater cutting torch was then suggested and decided upon by E. F. Mitchell, chief engineer of the railway. Arrangements were therefore made with the Merritt & Chapman Derrick & Wrecking Co., New York, who hold patents on the tool, to do the work.

A foreman, diver and equipment, including a 50-kw. turbine-driven generator set, switchboard, diving gear and all special appliances, were sent by boat from New York to New Orleans, where the generator was installed on a river tow-boat, and connected to its boilers. The necessary oxygen supply was taken on board, and the men and supplies transported to the bridge site, about 200 miles, by water. Cutting work was started Nov. 17, 1922, and completed in seventeen working days. Considerable time was consumed in washing fragments of the concrete from the bent sheet piles to make cutting more effective. Because of the character of bends, it was found necessary to make a second cut on five of the piles at the north end of the dam after the whole bent section had been severed and removed. A total of 67 hr. was consumed in actual cutting work and 47 hr. in jetting operations. It is estimated that in all about

450 sq.in. of steel were cut under water. Cutting off five piles was the largest day's work.

The cost of the work, including rental on the equipment and the towboat, transportation charges, subsistence for men, fuel, etc., was about $5,500, as against a minimum estimated cost of $35,000 by any other method. In addition, considerable time was saved.

The facility and celerity with which the work was accomplished were in large measure due to the energy and skill of the diver, John Tooker.

Upon the completion of the cutting, the bent cofferdam was lifted by tackle from the span above, fastened to the tow-boat and floated away. Plans for the restoration of the pier reinforcement are now under way.

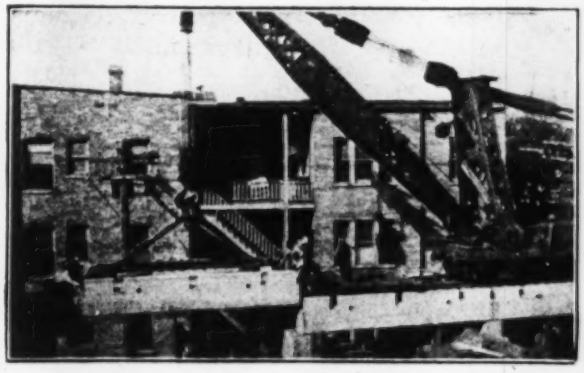
Handling Precast Bridge Slabs on Track Elevation: C., M. & St. P. Ry.

By T. H. Strate
Engineer of Track Elevation, C., M. & St. P. Ry.

In completing the track elevation between Irving Park Boulevard and Howard St., on the Chicago and Evanston Division of the Chicago, Milwaukee & St. Paul Ry. in 1922, a total of 236 bridge slabs was required. Of these, 115 were built in place and 121 were pre-cast at the slab yard, loaded onto flat cars, hauled to the job and set in place with a 50-ton derrick car. The latter plan was adopted principally on account of traffic conditions, as it was not desirable to give up certain sections of track for the length of time necessary to build the slab in place and allow it to season sufficiently for carrying load. These slabs varied in weight from 21 tons to 44 tons, the majority being in the neighborhood of 41 tons. Most of them were about 11x20 ft. and 36 in. thick. The accompanying view shows the placing of a deck slab on a trestle approach.

The precast slabs were made at a yard on the line extending from Galewood to Dunning and were loaded onto cars with a 100-ton wrecking crane, one flat car being required for each slab. Before the setting of the slabs could be commenced, the trolley wire and poles had to be removed on account of interference with the boom of the 50-ton derrick. Crossovers were installed so that slabs could be delivered to the derrick within the six-minute interval between trains. In some cases it was necessary to carry the slab for a distance of 1,000 ft. after it had been removed from the flat car. This was first attempted by placing the slab on small rail carriages, but the weight was too great. A four-wheel truck was then removed from a flat car and the slab placed on it and hauled to the opening. All of the weight, however, was not placed on the truck as the derrick still kept hold of the slab and carried probably half the load. On the openings north of Lawrence Ave., where it was not necessary to restore traffic each night, the maximum daily setting was eight slabs in eight hours, while the average was six slabs.

On the trestle between Wilson Ave. and Montrose Ave., which is single track (see *Engineering News-Record*, Dec. 23, 1920, page 1226), it was necessary to remove the trolley wire each morning and to replace it in the afternoon. It was also necessary to remove the trestle and close up the track again on account of the night freight service. This is the work shown in the illustration. The interchange of slabs was made at the siding just north of Wilson Ave., the loaded



DERRICK CAR PLACING CONCRETE SLAB

flat car being set on the main line, the slab picked off by the derrick and the car then pushed in the clear on the side-track. In this case the haul of the slabs after the derrick had taken them off of the car varied from 400 to 1,600 ft. The placing of six slabs was the maximum day's work, but the average for the job was only three per day.

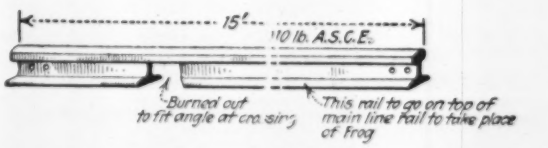
All of this work was done without any delays to the elevated passenger service, which, together with the Chicago, North Shore & Milwaukee R.R. service, amounted to approximately 200 trains during the eight-hour working period. Passenger traffic on this division is operated by the electric elevated railway and the North Shore line. Fortunately the rush-hour service interfered for only about one hour in the morning.

This track elevation improvement, with the exception of the station buildings, is being carried out by the railway company's forces under the direction of the writer as engineer of track elevation.

Temporary Frog Made by Fitting Burned Out Section Over Main Line Rail

By Frank B. Lee
Superintendent of Construction, Philadelphia, Pa.

In dismantling the high-tension tower line which fed Hog Island during the war, an obstacle was encountered in getting from the Pennsylvania R.R. main-line tracks to the old shuttle track, which is along the right-of-way of the transmission line. The frogs



BURNED OUT RAIL SECTION MAKES TEMPORARY FROG

and switches connecting these tracks had been removed, and the Pennsylvania R.R. would not allow them to be replaced for us to cross over.

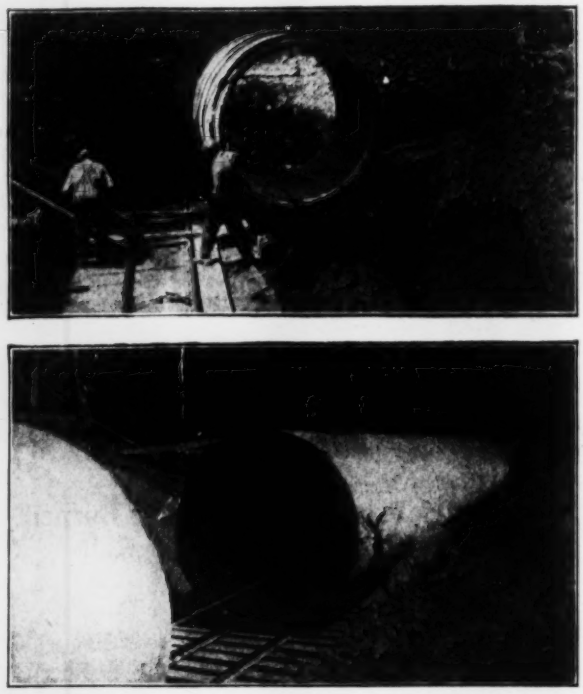
A temporary crossover was made in the following manner: The crossing rail at the frog location was made by burning out a section of rail at the right angle and placing the section on top of the main line rail and blocking this rail for support on the ties. This rail could be taken up and laid down in about ten minutes.

At the lead-off switch points were used with a 1½-in. plate to jump the main line outside rail.

Laying 7-ft. Concrete Pipe Culvert on New York Central Lines

THE methods of placing 84-in. reinforced-concrete pipe for a culvert on new railway construction are shown in the accompanying illustration. This work is on the new low-grade 5.4-mile cut-off between Hobson and Meigs, Ohio, built by the New York Central R.R. (Ohio Central Lines) for northbound tonnage trains. The line, which was opened for service on Sept. 19, 1922, has a grade of 0.2 per cent compensated for curvature and eliminates a long hill on the old line with a grade averaging 1.2 per cent.

At Station 140 it was decided to put in a culvert of 84-in. concrete pipe to carry a small stream through a 30-ft. fill. This culvert consisted of nineteen lengths of pipe, each 6 ft. long. The pipe was unloaded by a



HANDLING 7-FT. CONCRETE CULVERT PIPE
Above—Rolling pipe into trench.
Below—Hauling pipe along greased rails.

locomotive crane at a short distance from the site and was rolled down to the channel by hand. In the bottom of the creek a foundation was built of old ties and upon this was laid a track of 20-in. gage on a grade of 1.5 per cent, using 56-lb. scrap rail. The rails were thoroughly greased. By means of an incline at the upper end of the culvert each length of pipe was rolled down onto this track, being controlled by a cable wrapped around it, as shown. When in place on the rails a cable was passed through the pipe and attached to a tie laid across the rear end, so that a team could pull the pipe along the rails to bring it in contact with the pipe previously laid.

When all the pipes had been laid and jointed the rails were loosened and pulled out sideways by the team, leaving the pipes resting on the old ties. The fill was then placed. A camber of 8 in. was given to the culvert in construction and later it settled so that it is practically on the true grade. The soil was yellow clay and the stream was nearly dry at the time the work was done. Lowering and placing the pipe in its final position required about ten hours' time with a foreman, fourteen men and one team. The work was in charge of C. McVay, division engineer, and E. R. Neff, resident engineer.

From Job and Office

Hints that Cut Cost and Time

Concrete Handled in Dump Buckets on Illinois Central R.R. Job

DISTRIBUTING concrete in dump buckets conveyed on an industrial railway operated by a gasoline locomotive is the method employed by the contractor in building several subways on the track elevation work of the Illinois Central R.R. at Matteson, Ill., just south of Chicago. The structures include two railway crossings and three highway crossings, all consisting of concrete bents and abutments with slab decks. A total of 13,000 cu.yd. of concrete will be required.

As all the structures are included in a distance of 5,000 ft. a stationary concreting plant was installed on the east side of the tracks, a spur track for supply cars being laid from the main line and a stretch of about 2,500 ft. of 24-in. gage industrial track laid for the concreting cars. The mixer is of 1-yd. capacity, with gravity supply from overhead wooden bins containing 50 tons of stone and 30 tons of sand. A steam locomotive crane with 1-yd. grab bucket unloads stone and sand from cars, and a stiff-leg derrick with 65-ft. boom and 1-yd. bucket handles these materials from the stock piles to the bins. Cement in bags is stored in an adjacent shed and carried by buckets on the industrial cars, these buckets being lifted by the stiff-leg derrick to the mixer hopper. Water is piped to an overhead measuring tank. Charges of stone and sand are measured by means of a batch hopper.

The mixer is set on blocking at a sufficient height to

INDUSTRIAL RY. CARRIES CONCRETE BUCKETS

discharge into 1-yd. steel buckets which are carried by four-wheeled flat cars on the industrial railway. Two loaded cars are hauled by a 6-ton gasoline locomotive, as shown in the accompanying view. The haul is from 200 to 2,500 ft., on level track. For work near the plant, the buckets are handled and concrete dumped into the forms by the locomotive crane. At each more distant structure a stiff-leg derrick is installed to handle the buckets, either dumping the concrete directly into the forms or

From Job and Office

For Contractor and Engineer

into an elevated hopper with inclined delivery chute. This hopper is set on a temporary tower which carries a cable to support the chute. The concreting force averages ten men at the concreting plant, fifteen men at the structure being concreted, and one on the locomotive.

This work is being done under the direction of F. L. Thompson, chief engineer of the Illinois Central R.R., and T. H. Armistead, assistant engineer. The contractor is the Bates and Rogers Construction Co., Chicago, with A. S. Armstrong as its superintendent in charge.

Renewing a Long Slip-Switch by Wrecking Cranes: Pennsylvania R.R.

RENEWING a 114-ft. length of a double slip-switch 160 ft. long in a four-track main line by lifting it out bodily, with ties attached, by means of two wrecking cranes which then placed a new slip already built up the side of the track, was accomplished in 1 hr. 18 min. on the Pennsylvania R.R. near Johnstown, Pa. The weight was about 22 tons for the old slip with 100-lb rails, and 27 tons for the new slip with 130-lb. rails.

FIG. 2—CHAIN ATTACHMENTS, SWITCH POINT BLOCKS

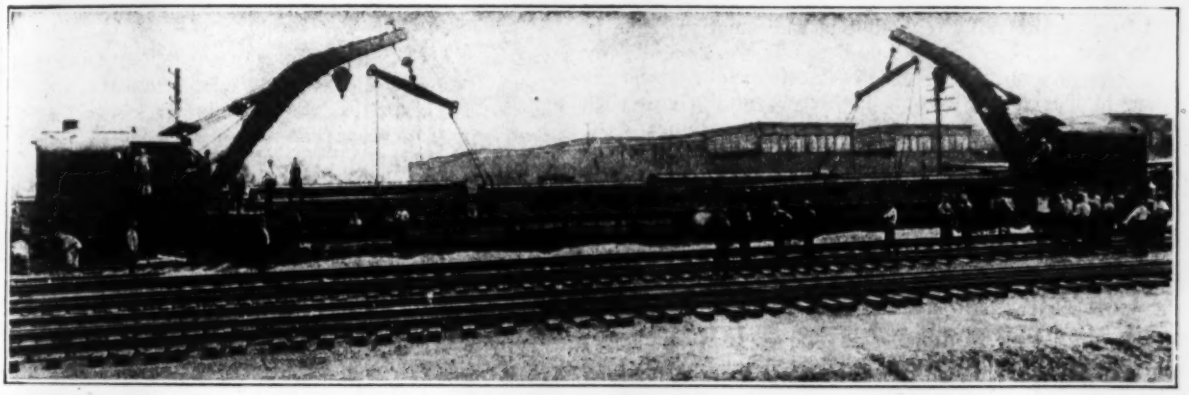


FIG. 1—WRECKING CRANES RENEWING SLIP-SWITCH; PENNSYLVANIA RAILROAD

These slips, with No. 15 frogs, were 160 ft. 7 in. long over heels of frogs, and the portion lifted out was 113 ft. 10 in. long. The greatest length of switch timbers or ties was 13 ft. In preparation for the lift, the ballast was cribbed or shoveled out from between the ties to the level of bottom of the ties, and a supply of fresh ballast was placed alongside the track ready for use. Fig. 1 shows the old slip slung between two 125-ton wrecking cranes.

The new slip-switch was built up complete directly opposite the site and alongside a yard track adjacent to the main tracks on which the work was to be done. Its construction included the stock rails which extended a few feet beyond the end switch points. No reinforcement of planks or other support was placed under the ties to stiffen the slip while being handled. It was necessary, however, to put blocks and wedges across the ends of the switch points to prevent them from lifting out of the switch-plate seats, as shown in Fig. 2. It will be seen from Fig. 2 also that for lifting the slip the chains did not pass under the switch timbers but those on the forward hold were applied round the rails at the heel blocks and those at the end next to the point were simply wrapped around the rails and switch point. With this arrangement no distortion of the slip resulted.

After the wrecking cranes had been spotted in position they were not moved until the entire operation was completed. Between them, but not filling the space between them, were placed two flat cars to hold the old slip temporarily while the new slip was lifted over it into position. With the derricks close enough to handle the load, the ends of the old slip lapped over their decks, as shown in Fig. 1. As this position would have interfered with swinging the new slip across the cars arrangements had been made to have oxy-acetylene operators at hand to burn off these lapping ends, thus allowing the slip to rest flat on the decks of the cars. When the new slip was in place the old one was landed clear of the track and there dismantled. The load and the difficulties of landing the slip longitudinally were increased materially by the fact that the cranes or derricks were not making a direct vertical lift but were pulling diagonally against each other, so that heavy anchorage of the cranes was required.

As soon as the old slip had been removed the roadbed was trimmed and ballast dressed to an even bed for the new slip. The end frogs were renewed while the slip was being handled. After the insulated joints had been connected up, some bar lining and surfacing was done and new stone ballast placed by hand before the track was put in service. For this work there were fifty-two track men in addition to the wrecking-crane crews. The renewal of this large piece of track was planned and carried out under the direction of E. O. Wood, assistant division engineer of the Pennsylvania at Johnstown.

Section House Moved Twenty Miles on Flat Car

BY DENNISON FAIRCHILD
Supervisor, Bridges and Buildings, Northern Pacific Ry. Co., Duluth, Minn.

WHEN A branch line of the Northern Pacific Ry. was recently abandoned, structures, track and other materials were salvaged. The photograph reproduced herewith shows the method in which a section house 23x29x26 ft. was moved on a flat car a distance of twenty miles.

The house was loaded rather high on the car so as to clear the narrow cuts, and was stayed by snubbing

RAILWAY SECTION HOUSE MOVED ON FLAT CAR

it to a car of rails in front and a locomotive crane in the rear. The crane was used to tilt the load slightly in passing obstacles, to steady it over particularly rough places, and keep it in better equilibrium when passing through curves of high super-elevation.

A heavy timber frame, shaped like the bottom of the building, was securely fastened to the car immediately in front of the house. This frame bunted away stumps and other obstructions met in transit and indicated whether the house would pass other obstructions.

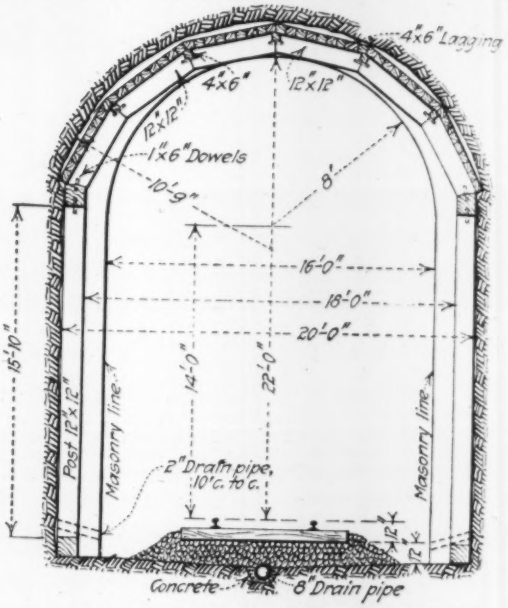
Concrete Tunnel Lining Poured Through Well Holes: C., B. & Q. R.R.

POURING concrete through vertical boreholes drilled from the surface of the ground was the method adopted for lining an old 700-ft. tunnel of the Chicago, Burlington & Quincy R. R. near Belmont, Neb. This method, which has been applied to sewer work for some years past, was employed in order to reduce the labor and time as compared with any method of handling concrete inside the tunnel, since it avoided all interference with traffic. From the surface to the crown of the tunnel the depth is 50 to 65 ft., mainly in magnesia rock known as Brule clay. After the old timbering had been pulled out by means of a hoisting engine and cable, the tunnel was enlarged to the required dimensions by men with drills and picks working on platforms which traveled along the track. These platforms were run out onto a sidetrack to clear trains. A typical tunnel section is shown herewith.

Two portable well-drilling outfits drilled 12-in. holes 16 ft. apart above the center line of the tunnel, the holes being lined with 8-in. or 10-in. iron casing as their net size permitted. The last hole at the south end was within 20 ft. of the portal, but at the other end a 93-ft. section of concrete lining had been placed a few years ago. A 1-yd. mixer was located on the surface nearly over the middle of the tunnel. Material was hauled up from the railway by teams and the sand and gravel were moved from the stock piles to the mixer by 1-yd. wooden dump cars on a 36-in. track.

Each batch of concrete was discharged into two wooden ½-yd. end-dump cars attached to a cable and running down grade on a 36-in. track laid directly over the line of bore holes. The mixer being at the highest point there was a descent for gravity loaded movements in both directions, the empty cars being hauled back by the cable. The two cars were dumped into two adjacent holes in order to secure a good flow over the forms, with an average distance of 8 ft. from each hole. A portable funnel or chute was fitted to the hole while concrete was being poured. Concreting was commenced at three points and the work progressed down grade along the tunnel to the north end. A 1:2:4 concrete mix was used, made with pit-run sand and gravel.

Timber forms in 33-ft. lengths were used, each form



LINING OF BELMONT TUNNEL: C., B. & Q. R.R.
Old timber lining was pulled out in advance of new concrete lining.

being left in place for 72 hours after pouring. Three of these lengths sufficed for the entire work. Concrete was poured over two forms for a length of 66 ft. (including side walls and crown) while the rear form was being collapsed, shifted ahead and set up in its new position. Pouring one 33-ft. length was a day's work. In all about 2,400 cu.yd. of concrete were placed in this way, forming the side walls and arch with a minimum thickness of 18 in. The walls were seated on concrete footings built in 1901, when the feet of the 12x12-in. posts of the timber lining had decayed so as to require repair. Concrete for the portals was delivered to the forms by the same ½-yd. cars used at the boreholes. These holes were filled with concrete to the surface, except that at four holes the casing was driven through the concrete to form ventilating shafts.

From Job and Office

Hints that Cut Cost and Time

From Job and Office

For Contractor and Engineer

Two portable well-drilling outfits were used by the railway in making the holes and a contract for the concreting was let to the Foundation Co., Chicago. This work was done under the direction of A. W. Newton, chief engineer, Chicago, Burlington & Quincy R. R., and F. T. Darrow, assistant chief engineer.

Tractor Used on Swampy Railroad Location

DURING 1922 the Florida East Coast Ry. made a survey locating a proposed extension from Okeechobee to Miami, Fla., a distance of approximately 122 miles, the route being through the Everglades except for about ten miles at the southern end. The purpose of the line is to develop the agricultural resources of a territory of about 1,670,000 acres, and to secure the traffic therefrom, but with the branch of which it is an extension it will also provide the railway with a second main track, 264 miles in length, between New Smyrna and Miami. As now located, the line follows rather closely along the east shore of Lake Okeechobee for a distance of about 45 miles, so that for this part of the work it was practicable to quarter the survey partly in houseboats, which were towed by a motor boat.

South of the lake, and between the North New River Canal and Miami Canal, the line was projected through country known as "muck" land, which was entirely submerged to a depth of one to three feet and covered with a rank growth of "saw grass," a rough bladed grass which will tear clothing to shreds. This muck land is an enormous peat bog, varying in depth from 3 ft. to 10 ft. Consequently it affords very poor footing, especially during wet seasons, and men walking over it will sink to a depth above the ankles.

If it was attempted to make a survey through this territory by ordinary methods the daily progress of the party would be limited by the amount of stakes and supplies that the men could carry, and the amount of line that could be cleared by use of axes or other hand tools. To do the work in this way it would have been necessary for the party to cover long distances on foot over this soft material, a severe task under the existing conditions. It was decided, therefore, that on account of the flooded condition of the Everglades, and the heavy growth of saw grass, it would be practically impossible to complete the survey of the 15-mile portion between the Fort Lauderdale and Miami canals by employing the methods in general practice on railroad surveys.

In an investigation to determine what methods should be employed, it was developed that a caterpillar tractor had been used on a canal location survey, in 1911, and subsequently on extensive township and section subdivision work in the Everglades. The general design of this machine had been worked out by F. C. Elliot, now chief engineer of the Everglades Drainage District, and the details and assembly by "Dad" Hill of the Buckeye Traction Ditcher Co. This tractor had not been used for some years and was found lying along the bank of the Palm Beach Canal, without engine, minus most of its gears and in bad condition generally on account of exposure. It was purchased and put in first-class condition, and the survey difficulty was thus solved. As shown in Fig. 1, the tractor carries a light steel frame which was covered with canvas, forming a house for the party, with accommodations for meals and sleeping quarters.

Four distinct advantages resulted from the use of this tractor: (1) The line was cleared without the necessity of using axemen and hand tools; (2) the soft muck was consolidated by the weight of the tractor, so that a substantially improved footing was provided for the party; (3) stakes and supplies were carried on a sled attached to rear of tractor, thus eliminating necessity of transportation by stakemen; (4) by keeping the tractor just in advance of the party, travel between work and camp was entirely eliminated and all meals were served in camp without delay to the work. A view of the survey party is given in Fig. 2.

In this way the line was run through the 15-mile stretch between the North New River and Miami canals in five days, while without the employment of the tractor, it is considered unlikely that any party of men would have undertaken the task. After the Miami Canal was reached the tractor was used in running line for twenty-five miles parallel to and alongside of the canal, but during this portion of the survey the party lived in the houseboats in the canal, as the quarters were larger and more convenient than those provided on the tractor.

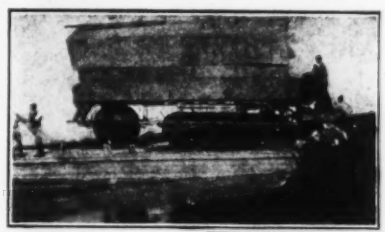


FIG. 1—TRACTOR FOR RAILWAY SURVEY IN THE EVERGLADES
Machine mounted on a lighter for transfer across Miami Canal.

FIG. 2—SURVEY PARTY IN THE EVERGLADES

For 40 miles south of the North New River Canal the line was through country inhabited only by wild cats, alligators, snakes and other wild animals and reptiles, and every station was staked out in water from one to three feet deep. This abnormal flood condition was due to continued heavy rains which began after the survey was started and caused the highest water in the Everglades for many years. To carry out this survey, therefore, required a party of men with plenty of stamina. Realizing that hardships would have to be endured, the company provided good quarters, food and equipment and a camp physician. As a result the survey was completed successfully, economically and without serious illness in the party.

H. N. Rodenbaugh, then chief engineer (now general manager), was in charge of the work, which was carried out under his direction by Calvin Oberdorf, then principal assistant engineer (now engineer of construction); A. A. Jackson was assistant engineer of construction and J. E. Lucas was chief-of-party.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Morrison Street Bridge Reinforcement

Sir—In your issue of Nov. 30, 1922, p. 947, a letter entitled "Doubtful Bridge Reinforcement" was published over the signature of George Rae. The sketch accompanying the letter, together with the description, identifies the structure referred to as the Morrison St. bridge in Portland. The statements made in the letter are totally in error.

The facts of the matter are that the alleged great deflection of the span when it was repaved in 1921 did not occur; that the deflection which occurred at the time of repaving was 2.46 in., the measurement almost precisely checking the previously calculated amount and being, of course, duly taken care of; that the bottom chords of the bridge did not on any occasion buckle as charged, nor did any contractor make or announce such a "discovery" so far as the writer knows; and that, while Mr. Rae's description of the emergency repairs is in a rough way correct, his speculations as to the stress conditions and the weakening of the chord are wholly without foundation; that the timbers were attached to the lower chord not to take compression, but to stiffen the chord where it had been slightly kinked at the fourth panel point from the end by an accident which sheared the end latches.

It may be of value to the bridge engineering reader to know that the emergency reinforcement is not designed with a view to having the wood and steel act in unison, but with a view to having the timbers stiffen the chord. The two timbers are, however, capable of carrying the entire chord stress without reliance on the steel, at usual allowable unit stresses. I need hardly add that the bolt holes by which the abutment castings are attached to the chord do not weaken the chord, both because the limiting net section in the panel is at the pin or splice plates near the joint, and because this particular chord panel contains considerable excess metal and even with several additional bolt holes out it would never get as high a stress as adjacent panels of the chord.

Mr. Rae's insinuations against the competence of the two county officials under whose direction the construction work was carried out are, of course, wholly reprehensible. As already stated, the reinforcement work was designed by the writer. It was carried out by the two officials in question, in most excellent manner. The work was done on a cost-plus basis, at a total expenditure of about $3,000, with a saving of four weeks in time and possibly 25 per cent in cost.

Quite apart from the unwarranted criticisms just referred to, the Morrison St. bridge is highly interesting because of an agitation several years ago to have it replaced by a new bridge. At that time a careful investigation was made by the writer's department and an exhaustive report prepared, at a cost of about $6,000. It was found that more than $1,000,000 could be saved by adopting a system of repair work rather than renewing the structure. There was a popular belief that the bridge was unsafe, which was never the case, and had it not been for the careful investigation made at that time the public would unthinkingly have been plunged into a needless investment running into millions. Of the $208,000 repair program recommended, all has been completed with the exception of one contract involving about $40,000. When this work is completed, the entire cost for repairs will be below that originally estimated, and the structure will be safe for unrestricted traffic for a service period of ten to fifteen years.

C. B. McCULLOUGH,
Bridge Engineer, Oregon State Highway Commission.
Salem, Feb. 13.

Faults in the Tacoma Arch

Sir—The failure of a skew arch described in your issue of Feb. 22, p. 355, should have more notice than a mere passing slap at laitance and excess water in concrete.

In at least two respects the design of this arch is subject to serious question.

The curve of the arch is semi-elliptical. The semi-ellipse is not the equilibrium polygon for vertical loads. It is only by assuming large horizontal forces at the haunches that a curve approaching a semi-ellipse will result in the equilibrium polygon. In my book "Concrete" I point out, on p. 15, that the semi-ellipse or basket handle is not the proper shape for an arch in any other position but a subaqueous tunnel: this is because of the absence of an active horizontal pressure of the earth over the haunches and the abutment earth *may* exect a large horizontal pressure, and again it may exert practically no horizontal pressure whatever. It may even dry out and shrink away from a retaining wall.

Arches should be designed on the assumption that no horizontal pressure is exerted on the haunches and against the abutments. The stability of the arch depends on designing on this assumption.

This arch broke exactly where it would be expected to break without the aid of active horizontal pressure on the haunches, namely, at the sharpening of the curve in the haunch. The absence of horizontal pressure results in an excessive bending moment at the point where the break occurred. When the ring of the arch was broken by this bending moment, the horizontal thrust would immediately come into play, causing the shearing break.

The other seriously questionable feature in this design is the large skew. The thrust of skew arches tends to act normal to the axis of the barrel of the arch and not parallel with the face; hence the greater the skew, that is, the farther the abutments are thrown from positions opposite one another in lines normal to the axis of the barrel of the arch, the greater the disadvantage at which arch action comes into play. If the three "ribs" of this arch had each been made a square-ended arch, and thus steps made in the skew, there would be reason for separating the ribs; but to separate these ribs as the designer has done simply accentuates the skew and loses the help that one rib might have offered the other. EDWARD GODFREY.

Pittsburgh, Pa., Feb. 27, 1923.

Tests on Effect of Paint Between Riveted Plates

Sir—Referring to A. Sabin's article, "Paint to Prevent Rusting Between Plates," in *Engineering News-Record* of Feb. 8, p. 271, I believe some additional light would be thrown on this subject by the attached correspondence, in reference to certain paint tests made in connection with the erection of the Metropolis Bridge.

Pittsburgh, Feb. 14. RICHARD KHUEN, JR.,
General Manager of Erection, American Bridge Co.

Mr. C. R. Fickes, Chief Engineer,
Paducah & Illinois R.R. Co.,
Metropolis, Ill.

Dear Sir:—

To demonstrate the effect of paint upon contact surfaces in riveted work, we have in accordance with my understanding of your wishes provided six 12 x ½-in. plates 3 ft. 2 in. long, each plate punched for ¾-in. rivets spaced transversely 3 in. centers with edge distances of 1½ in., and longitudinally 3½ in. centers with edge distances of 1½ in., this spacing corresponding with spacing in chord splices, etc., of the Metropolis Bridge. With these plates, we have made the following tests:—

Test No. 1.—We painted each surface of each plate with three coats of Dutch Boy red lead paint, composed of 67 lb. of red lead to 1 gal. of boiled linseed oil, and 1 gal. of raw linseed oil and 0.33 gal. dryer, allowing proper drying time between each coat of paint. We then put the six plates together, bolted them up tightly as a regular joint would be fitted, and drove the 44 rivets, driving the middle

rows first, and after the rivets and plates had cooled off, cut the rivets out and separated the plates.

Test No. 2.—This test is a duplicate of No. 1, except that two coats of paint were applied to each surface of each plate instead of three.

Test No. 3.—This test is a duplicate of test No. 1, except that one coat of paint was applied instead of three.

Between each test, the plates were thoroughly cleansed of all paint left from the prior test.

Our foreman reports the following results:—

In Test No. 1, during the riveting of the plates together, the paint boiled out over the edges to a very considerable extent. After the plates were riveted together, the rivets were tested and 25 per cent of them found loose. After the plates were cut apart, the paint on the contact surfaces was found to have been reduced to a powder, which could be easily removed by blowing or dusting off, on a large proportion of the surface.

In Test No. 2, the same boiling, of a less degree of the paint in the joints was observed and as to the rivets 10 per cent of them were found loose. After cutting apart, the painted surfaces showed a little more live paint but still largely reduced to a powder.

Test No. 3 showed considerable boiling during the riveting operation and upon testing the rivets showed 5 per cent loose, and upon cutting the plates apart showed the surfaces with considerable paint.

I understand that these tests were watched carefully by your inspectors and I would very much appreciate advice from you, first, checking or correcting the above statement of facts as we understand them, and second, your conclusion as to painting of contact surfaces in riveted joints for the balance of the work.

Yours truly,
H. A. GREENE,
Division Erecting Manager,
Pittsburgh, Nov. 29, 1916. American Bridge Company.

Mr. H. A. Greene, Erecting Manager,
American Bridge Co.,
Pittsburgh, Pa.

Dear Sir:—

Your tests were carefully watched by me and also by my inspectors and in general what you say regarding the tests are the facts. My conclusion in regard to this matter, after seeing the tests made, is that one thin coat of red lead in oil carefully brushed in on each of the surfaces in contact is the proper method of treating the plates in riveted joints. During the balance of the work we will not insist on repainting the entire surface of surfaces which are in contact and riveted in the field, but will insist that spots where the paint has been scraped off and which have begun to rust be cleaned and given one thin coat of paint.

C. R. FICKES,
Chief Engineer, Paducah & Illinois R.R. Co.
Metropolis, Ill., Dec. 8, 1916.

An Engineering Substitute for the Cellar Door

Sir—The "spillway for kids" shown in picture and section for this article, having a total height of 5 ft., ice-surfaced, is safe for kids who can walk and entertaining for the boy or girl up to 15 years of age.

No sleds are necessary. They float down, slide down, roll down, singly, in twos or in spirals. But when my 33 months' boy started to *leap* down from the foot-rest shown, while others older stood on and leaped from the apex, then came the real test of the remarkable properties of this particular curve.

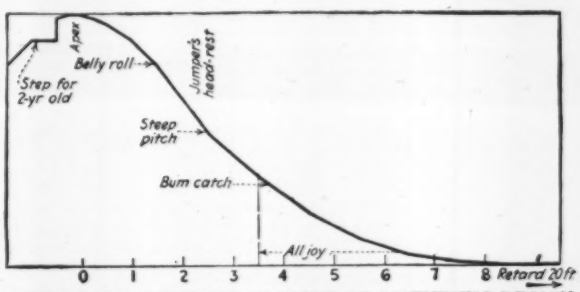
Whether it closely resembles the standard water spillway I have not yet verified; but I cross-sectioned it, and intend to keep on building them next winter, at $5 a piece, if the engineering trade is dull. Those who can afford it will be taxed $10.

A good deal of water is necessary. Settled snow is thrown in blocks into a heap and the water applied at irregular intervals for packing. It is necessary to keep the idea of steepness in mind to start with; but otherwise the face is given very little attention till near the end of the job. Then it is smoothed somewhat with a shovel, and the water first sprinkled, then "sloshed" on it, picking a real cold day. After that, maintenance consists in sprinkling both it and the retarding apron at intervals of a week or so.

A good firm top, with square shoulders is desirable. The base will need to be 10 or 12 ft. either way; steps lead up to the rear. Water should be thrown over the sides also when the weather permits, in order to provide a good coat against the spring sun.

Heads cannot be broken on this slide. G. P. MORSE,
Assistant Engineer,
Winnepeg, Man., Feb. 10. Public Works of Canada.

[This recalls an incident about twenty years ago when a new toboggan slide was to be put up at an eastern university. An enthusiastic engineering student remembering a page in his calculus saw to it that the slide was built to the



A HOME-MADE TOBOGGAN SLIDE OF SCIENTIFIC DESIGN

mathematical "curve of least descent," on the theory that such a curve would get the toboggan to the bottom quickest and therefore with the most excitement. If recollection serves, the first toboggan, carrying the designer, clung to this nicely calculated curve along its slowly descending upper slope but at the point of curve where the descent began to steepen the toboggan shot out into the air in a perfect tangent and, after achieving a middle ordinate of about 20 ft., landed pretty well smashed on the flattened slope at the bottom of the slide. The reconstructed slide, on conventional lines, was another triumph of practice over theory.—EDITOR.]

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

At a recent meeting of the Colorado Engineering Council it was agreed that Colorado Senate Bill 265, calling for an appropriation of $25,000 for state mapping work, be made to read $50,000 so as to take full advantage of money available from the U. S. Geological Survey for mapping purposes.

Hard-surfaced roads, contained in a 173-mile system, are to be built with money provided by a $2,500,000 bond issue that Champaign County, Illinois, passed Feb. 27, by a two-to-one vote. Most of the highways will probably be of concrete, 9 ft. wide to be widened to 18 ft. as traffic demands.

Plans are under way for the annual meeting of the Building Officials Conference to be held in Toledo, Ohio, April 24-27. Aside from various technical discussions there will be committee reports, among the latter being a report upon the building code recently published by the U. S. Department of Commerce. A complete program will be announced sometime this month.

Endorsement of the plan for establishing a national hydraulic laboratory was contained in a resolution passed by the Boston Society of Civil Engineers at a recent meeting. The society had previously endorsed the resolution by letter ballot. Congressmen from Massachusetts are to be sent notice of the society's action.

The twelfth annual conference of Lockwood, Greene & Co., engineers and managers, of Boston, was held Feb. 28, March 1 and 2, in Boston. A feature of the program was a clinic for managers identified with dental and medical work of the mills over which the Lockwood-Greene company has administration.

Preliminary work on changing the channel of the Arkansas River through Pueblo, Colorado, and increasing the carrying capacity to avoid repetition of the destructive flood of 1921, is under way. The Dayton-Morgan Engineering Co. has investigators at work and when a complete report is available, probably within three or four months, bonds will be issued and contracts to do the work let.

The Colorado State Supreme Court has found that the Colorado conservancy law, passed by the general assembly in 1921, is valid. Opponents to the law sought to have it declared unconstitutional. The purpose of the bill is to enable the people of Pueblo to protect themselves against a repetition of the disastrous flood of 1921, when millions of dollars worth of property was destroyed and many lives lost.

New York Governor Urges State Water Power

In a message to the Legislature on Mar. 5 Governor Smith, of New York, strongly reiterates his previous demands for a state owned water-power system. The message first points out the huge water power resources in the state, especially in the Niagara and St. Lawrence Rivers and then says that the state "should develop these power resources and transmit energy created thereby to every municipality over transmission lines owned and controlled by the state." He therefore recommends: one, legislation to carry out this policy; two, that the state engineer be clothed with power to begin such development at once; three, that pending this development existing transmission lines should be declared common carriers; four, that no further private licenses be issued; and five, that $75,000 be immediately appropriated to defray the expenses of the suit of the State against the legality of the Federal Water Power Act.

Bill to Reclassify Government Employees Passed by Congress

Washington Correspondence

Material increases in the federal government salary scale are provided in the reclassification bill, which was passed just before Congress adjourned. The act, signed by the President March 4, is known as the Sterling-Lehlbach bill.

The new schedules will not go into effect until July 1, 1924. A special board headed by the Director of the Budget is charged with the actual reclassification, which must be effected to determine the employees who are entitled to the increased salaries.

Inasmuch as the legislation was pushed through during the last hours of the session, printed copies of bill are not yet available.

Engineering Council's Executive Board to Meet March 23-24

Government reorganization and reforestation will be among the chief questions to be discussed at a meeting of the Executive Board of the American Engineering Council, the executive body of the Federated American Engineering Societies, to be held March 23-24, in Cincinnati. As a part of the reforestation program, the co-operation of the government and of the Federation in a nation-wide campaign to conserve the country's forests is announced by Dean Mortimer E. Cooley, president of the Federation. The campaign is the result of a conference with Col. W. B. Greeley, chief of the U. S. Forest Service. It is planned to enlist the aid of engineers in all parts of the country in the reforestation movement, working in co-operation with state forestry services, organizations of farmers, universities, railroads and other bodies.

Direct Oxidation Company Accuses Engineer

Charges Clyde Potts With Holding Up Plans for Trenton Sewerage-Works Before State Board of Health

The Direct Oxidation Disposal Corporation of Philadelphia has filed charges with the governor of New Jersey against Clyde Potts, consulting engineer, New York City, and one of the two engineer-members of the State Board of Health, for holding up for improper personal reasons the plans for new sewage-works of the direct-oxidation or lime-electrolytic type for Trenton, N. J., drawn by Col. George A. Johnson, consulting engineer, New York City. All the charges except those relating to motive bear the approval of Colonel Johnson. By request of *Engineering News-Record*, Mr. Potts has supplied a copy of the charges for publication here, as follows:

DIRECT OXIDATION DISPOSAL CORPORATION
LAND TITLE BUILDING
PHILADELPHIA

Hon. George S. Silzer,
Executive Offices,
Trenton, N. J.

Feb. 19, 1923.

Sir:

The Court of Chancery has issued a mandatory decree to the City of Trenton to build a sewage disposal plant. The City of Trenton has complied with the Court decree by having its Engineering Department, aided by a competent and internationally recognized consulting engineer, investigate and report upon the various types of sewage disposal plants and processes, and to prepare plans and specifications therefore. (Initialed G. A. J.)

The plans, specifications and reports of the Engineering Bureau of the City of Trenton have been submitted formally to the Engineering Bureau of the State Department of Health. Date of submission, Dec. 15, 1922. (Initialed G. A. J.)

It is necessary to point out that the State Department of Health, in the face of endorsement by its own Engineering Bureau of the plans and specifications of the City of Trenton so submitted, and despite the request of the City of Trenton for immediate action in order that the city might properly comply with the Chancery Court decree, and also that the city might take advantage of the lower prices it could obtain by letting a contract during the past winter, has failed, since Dec. 19, 1922, to give its approval of the project so submitted. (Initialed G. A. J.)

This failure, inexplicable in view of the face germane, on the part of the State Department of Health to accept the engineering verdict of its own bureau which has to do with such matters primarily, is attributable un-

equivocally to one member of the State Department of Health, Mr. Clyde Potts, a consulting engineer of New York, and also mayor of Morristown, N. J. (Initialed G. A. J.)

Mr. Potts has set himself against all other engineering opinion, and is opposing the program proposed by the City of Trenton, recommended by its consulting engineer and its own engineering staff, and for which funds have been provided to defray the cost of construction. Unanimous opinion of the Board of City Commissioners in favor of this project, approving the recommendation of the city's consulting engineer without internal dissension, involve an expenditure of $1,063,000 as against a cost of nearly $2,000,000 for a discredited type of sewage disposal system, favored by Mr. Potts. (Initialed G. A. J.)

Mr. Potts has never given any public reason, technical or otherwise, for opposing this newer and cheaper system proposed for Trenton, which is now in successful operation on a smaller scale in the cities of Allentown, Pa., and Phillipsburg, N. J. There appears to be no reason why he should oppose the approval of this project for the City of Trenton, as a member of the State Department of Health of New Jersey, except that he sought and was denied the donation of a large stock interest in the patented process involved in the system recommended to and unanimously adopted by the city commissioners of Trenton.

The efforts of Mr. Potts to secure an interest in this process were made by him after a study of the then available facts pertinent to it. Inasmuch as he has since made no further investigation of it, his attitude, in advising the State Department of Health to withhold its approval of the project submitted by the City of Trenton, cannot be ascribed to engineering reasons.

This evidence is submitted with the thought that when the State Department of Health, possessing as it does broad powers—indeed it would seem in the existing circumstances powers improperly plenary, in view of the matter in which they are now being exercised—is operating in a fashion inimical to the best interest of the citizens of New Jersey, and the public at large. On this account the foregoing is respectfully submitted for the immediate and serious consideration of the chief executive of the state. (Initialed G. A. J.)

Very truly yours,
H. JEROME HIRST.

Approved as initialed
G. A. JOHNSON,
Consulting Engineer.

It is reported that the delay in acting on the Trenton plans had been due to a feeling of uncertainty on the part of members of the board as to the suitability of the direct-oxidation process for Trenton, which had finally led the board to authorize Dr. Henry Spence, president of the board, Mr. Potts and R. J. Harder (city engineer of Paterson) the other engineer-member, and H. P. Croft, chief engineer of the board, to obtain outside expert advice before deciding on what action to take.

Governor Silzer has referred the charges to the State Board of Health.

Rock Foundation Failure Causes Collapse of New Building

An apartment house under construction on Crotona Park North, New York City, collapsed just after working hours on March 2, under unusual circumstances. The outside walls did not fail and were only locally damaged, but the five floors fell, pointing toward the longitudinal center line of the building, and the upper part of the front wall was also carried down. The building was framed with transverse wooden joists carried on the stone and brick side walls and on a short wall and girders running front to back through the building. The short wall fell, while the posts and piers carrying the girders remained standing. The wall that failed was built of local stone, in cement mortar that had set hard and bonded the wall well. It rested directly on rock at cellar level. Failure of this rock foundation caused the collapse of the wall.

The rock here is Manhattan schist. A trench about 2 x 2 ft. for the house sewer had been cut in the rock directly along the base of the wall, and a few hours before the collapse a couple of laborers had been sent to trim the sides of the trench to give more working room. This trimming apparently loosened the rock under the wall enough to bring about the failure.

Construction was going on with no supervision except that of the owner, a real estate man who was acting as his own general contractor.

32 Proposed Bills Would Merge N. Y. State Agencies

The exhaustive reconstruction program introduced in the New York Legislature by democratic leaders March 5 embodied in 32 bills the consolidation of over fifty agencies of government. A feature of the program is the proposed consolidation of all machinery which has to do with engineering, architecture and building.

This important measure establishes the new Department of Public Works, which would comprehend in its jurisdiction the functions now scattered throughout the highway department, the inter-state bridge commission, the department of public works, the department of public buildings, the trustees of public buildings, the office of state architect, the boundary waters commission and river regulating districts. The department would be organized with four main bureaus to which would be given the work of the several offices taken over:

The Bureau of Highways;
The Bureau of Canals and Water Control;
The Bureau of Architecture;
The Bureau of Public Buildings.

At the head of the Bureau of Highways is the highway commissioner; at the head of the Bureau of Canals and water control is a deputy superintendent of public works; at the head of the Bureau of Architecture is the state architect; at the head of the department of Public Buildings is the superintendent of public buildings. As the executive head of the entire organization, the superintendent of public works would stand with concentrated responsibility and complete control of all of the public works of the state.

Minnesota Engineers Meet with Federation

Joint Sessions Produce Interesting Program of Civic, Welfare and Technical Discussions

Engineering News-Record Staff Report

In a joint meeting of the Minnesota Federation of Architectural and Engineering Societies, representing ten organizations, and the Minnesota Surveyors and Engineers Society Feb. 21, 22 and 23 the former furnished the general technical program and bulk of the welfare and civic topics while the state society provided excellently devised technical programs for its three sections (highway, municipal and drainage) and a minimum of discussion on organizations, welfare or civic activities.

The engineer in Minnesota apparently is buckling down to his duties as a citizen. This was apparent not only in the exhortation to greater civic service in the address of W. H. Woodbury, president, but also in the highly satisfactory report of the six major activities of the public affairs committee, in the activity of the legislative committee in pushing bills in which engineers have interest, and in getting the accomplishments of the engineer to the public by proper publicity methods.

FEDERATION'S PROGRAM

The technical program of the federation was designed to be of main interest to men outside of the particular specialty. In consequence, the subjects were handled in a semi-technical manner and with the exception of detailed treatment of economic highway location by O. L. Kipp, engineer with the state highway department, covered such subjects as wood waste, water treatment, city planning, use of power on the farms of Minnesota and a general survey of scientific development.

Work of the federation for the past year has centered on its public affairs and legislative committees. Peat utilization is still being studied; and the Great Lakes-St. Lawrence Waterway interests furthered. A state lighting code has been written and the legislative committee authorized to push it through the legislature but to withdraw it if it should be emasculated by amendment. Endorsement was given to successive road bond issues of $10,000,000 each for 1923 and 1924. Backing for appropriations for the sanitary engineering program of the state board of health and for topographic and hydrographic mapping. The "toothless" engineers registration law is to be amended to extend the penalties to out-of-state engineers, to exempt only "elective" but not "selective" municipal or county engineers and to reduce the $5 renewal fees. In addition to these activities resolutions called for the continued co-operation between the state highway department and the state university in research work, for the state board of health to furnish tourist camp inspection and for increased activities of planning and zoning.

By restricting to a minimum the technical matter in the *Bulletin* its cost has been reduced so that now it is nearly self-supporting and the dues to the federation are to be reduced from $4 to $3. The first six months of 1922

(*Continued on p. 465*)

A.A.E. Board Acts on Registration Laws

Authority Given to Combat Repeal Attempt in Pennsylvania—Other Business

In addition to a resolution calling for the immediate trial of those against whom indictments or suits have been instituted charging fraud in cantonment construction (see *Engineering News-Record*, March 1, p. 412), the board of directors of the American Association of Engineers at the recent quarterly meeting authorized action to combat a movement to repeal the Pennsylvania engineers' registration law; recommended the elimination from the proposed registration bill in Tennessee of a provision granting licenses on the basis of society membership; and authorized a study of the unification of engineering organizations. Co-operation with other societies and formulation of principles bearing on the subject will be undertaken by a committee consisting of H. C. Ferry, director of California; B. W. Matteson, director of Utah; G. M. Butler, director of Arizona, and D. L. Turner of New York. The committee is to report at the annual meeting in Norfolk, May 7-9. A committee on Americanization, headed by Elon H. Hooker, New York, was appointed.

The judiciary committee membership has finally been made up as follows: L. E. Ayres, 1 year; Paul Augustinus, 2 years; R. P. Luck, 3 years; L. K. Sherman, 4 years; H. C. Clausen, 5 years. This committee is the final court of the association and will pass on all questions submitted to it by the board, by the practice committee or by twenty members.

CANDIDATES FOR OFFICES

Nomination by petition of candidates for offices to be voted on at the 1923 election are as follows: President, W. L. Benham, Kansas City, Frank T. Payne, New Orleans, R. I. Randolph, Chicago, George E. Taylor, Charleston, W. Va.; first vice-president, L. E. Ayres, Will P. Blair, G. M. Butler and A. M. Knowles; second vice-president, Morris Bien and W. H. Strong; directors, W. H. Marsh, district 1; H. C. Ferry, district 2; J. C. Nagle, district 4; J. E. Kaulfuss and Clark E. Mickey, district 5; Dan W. Patton, district 6; W. R. Harris and Henry Riedl, district 7; M. Z. Balf, district 10 and P. Sellers, district 12.

Application was approved for the Oklahoma Engineering Society to amalgamate with the chapters of the state to form the Oklahoma Division.

Mississippi River Problem to Be Am. Soc. C. E. Topic

The river and harbor problems of the lower Mississippi will be the basis of the technical discussions at the spring meeting of the American Society of Civil Engineers to be held at New Orleans April 18, 19 and 20. Social features will supplement the technical sessions, and there will be excursions through the French quarter of New Orleans and an all-day boat trip around the harbor. Various nearby engineering projects will as well be inspected.

Congress Grants Coal Commission $400,000 Appropriation

Washington Correspondence

While the continuance of the President's Coal Commission was imperiled by the delay in voting its appropriation, Congress, in an eleventh hour effort gave the Commission all of the legislation which it had asked. This included the appropriation of $400,000; the authorization to require sworn answers to questionnaires; the extension of the life of the commission until Dec. 31 and the authorization for Judge Alschuler to serve as a member of the commission.

The appropriation was added to the third deficiency bill in the Senate. It was approved with practically no objection. A separate vote on the amendment was demanded in the House, but the item was approved without a roll call. Prior to that action, however, the House had passed the bill which authorizes the Commission to require sworn answers to its questionnaires. The amendments to the original act included the desired increase in the appropriation.

Pennsylvania Plans Highway Traffic Survey

A highway transport survey is planned by the Pennsylvania State Highway Department. In an announcement by Paul D. Wright, commissioner, and William H. Connell, deputy commissioner, it is stated that in this survey "our engineers will consider the importance of feeder territory as to its agriculture, its industries, the population of the towns and cities. They will consider the trans-Pennsylvania traffic which will pass through their districts and the logical route for this traffic to follow. They will endeavor to determine through reasonable deduction the probable development of feeder territory. The material gathered in various section of the state will be studied as a whole; and the result will be a composite picture of Pennsylvania's highway requirements for years to come. We shall determine from the normal road use of the present and the result of our studies of the future what highway types will be necessary. The survey will aid in the conservation of the state's financial resources, because it will give Pennsylvania the best possible road system at the least possible expenditure of public funds."

Smith Proposes Port Authority and Tunnel Commission Merge

Governor Smith has written a letter to Governor Silzer of New Jersey, asking him to join in considering a plan to bring about a consolidation of the Port of New York Authority and the Vehicular Tunnel Commission. Governor Smith asserts in the letter that when the vehicular tunnel is completed it will logically be a part of the general plan to improve the Port of New York. There would be many advantages, he believes, if the vehicular tunnel project were transferred to the jurisdiction of the Port Authority. Under such a merger the Port Authority could issue its own bonds for financing the tunnel project from now on, relieving the taxpayers in both states from further burdens.

Garrett Blocks U. S. Participation in International Road Congress

Washington Correspondence

Unexpected objection raised during the closing hour of Congress by Representative Garrett, the Democratic leader, resulted in the defeat of the resolution providing for American representation in the Permanent Association of International Road Congresses.

Representative Anderson, of Minnesota, explained that the cost of membership is negligible and that the United States should participate in the exchange of views in the matter of road construction. He pointed out that the proposal not only has the endorsement of the President, the Secretary of State and the Secretary of Agriculture, but in addition was recommended by Secretary Meredith, who was in charge of the Department of Agriculture during the preceding administration. Despite these facts and others presented on behalf of the resolution, Mr. Garrett insisted on his objection just at the time the friends of the resolution were rejoicing in the fact that they had been able to get the resolution before the House. It had been taken for granted that no one would object.

Congress Gets Another Bid for Muscle Shoals Property

Washington Correspondence

Another bidder for the Government's project at Muscle Shoals appeared in the closing days of the 67th Congress when a bill was introduced by Representative M. J. Hogan, of the Seventh New York District, to authorize the Secretary of War to dispose of the Government's property to John Kissel and unnamed associates.

Mr. Kissel represented the Third New York Congressional District in the House of Representatives. He has been a newspaper publisher and is prominent in Kings County, New York, politics. Both Representative Kissel and Representative Hogan retired from the House Mar. 4.

The terms of the bill as introduced by Representative Hogan are identical with those of the revised Ford offer for Muscle Shoals, which are contained in the bill introduced by Representative Wright, of Georgia, to accept the Ford offer. The exact terms are followed in the Hogan Bill excepting that instead of paying $5,000,000 to the Government, the Kissel bid would pay $6,000,000 and extend the time of payment from five to six years.

Shipping Board to Recondition Two Former German Liners

The United States Shipping Board has announced that it has authorized the reconditioning of the steamships "Agamemnon" and "Mount Vernon." Both vessels are ex-German liners, the "Agamemnon" having been formerly known as the "Kaiser Wilhelm II." and the "Mount Vernon" as the "Kronprinzessin Cecilie." It is expected they will be ready for service in the 1924 season, when they will be operated by the United States Lines in the North Atlantic in conjunction with the "Leviathan" and the "George Washington." Both will be converted into oil burners. The vessels are approximately 700 ft. long, with a gross tonnage of about 20,000 tons and a speed of 23 knots.

Minnesota Engineers Meet

(*Concluded from p. 463*)

t cost 20c. per member and the last six months 33c. per member per month. The membership now numbers 1,163. One society, the St. Paul section of the American Society of Mechanical Engineers, has withdrawn.

Nine technical papers presented to the highway section of the Surveyors and Engineers Society, which was attended by 225 state and county engineers and officials, covered the use of marl, subgrade analysis, gravel location, Bates and Pittsburg road tests, snow removal, marking, county aid work, contractors point of view on materials and bridge maintenance.

Highway Section—Charles H. Dow, in reporting on three roads made of marl and sand like a sand-clay road indicated that the greater tendency to become dusty may be overcome with calcium chloride, that unlike sand-clay, marl-sand resists the penetration of water, that although more compressible, marl-sand ruts less easily as it retains its molded shape under pressure while sand-clay flows under pressure. The university experiment station has just issued a bulletin covering Mr. Dow's work which was carried out cooperatively by the university and state highway department.

C. L. Mott, of the state highway department, explained how to use the available geological information in hunting gravel deposits.

E. O. Hathaway, of the U. S. Bureau of Public Roads, outlined briefly the Bates and Pittsburg road tests giving his conclusions on the capacity of surfaces and subgrade to support loads, the temperature effect, effect of traffic and its distribution on the surface.

Snow removal experiences on a 100-mile stretch of road north of Lake Superior from Two Harbors to Grand Marais beyond the end of the railroad were given by P. D. Mold, of the state highway department. Drifts 12 ft. deep following a gale of 70 miles per hour were opened in three days after the blizzard the middle of February. Including snow plow equipment the average cost per mile will be under $150. Discussing the paper of J. A. Myron on marking Mr. Mold stated that he had plowed up most of the markers on this road, indicating the necessity of locating them beyond the shoulders.

E. J. Miller outlined the inspection procedure of the state highway department, the method of calculating whether it was cheaper to repair or renew old bridges.

Municipal Problems—The municipal section, after a discussion on fire prevention methods, brought in a resolution passed by the whole society calling for uniform hydrant threads. Later the proposal will go to the federation for final endorsement and possible legislative action. Garbage in small towns was discussed by F. D. Minium, city engineer, New Ulm. O. E. Brownell, assistant engineer of the state board of health, read a paper on "The Disinfection of Wells, Reservoirs and Distribution Systems to Remove Indications of Contamination."

Drainage Section—Thaddeus Surber, biologist of the state game and fish department, warned the drainage section of the dangers to the state's water resources of excessive drainage through lowered ground water, smaller rainfall and more rapid runoff.

A progress report was submitted on the problem of obtaining better tile by D. G. Miller, senior drainage engineer, U. S. Bureau of Public Roads. E. V. Willard, state commissioner of drainage and waters, outlined the state's procedure in the inspection of tile. The section asked the society to approve further co-operation in research on drainage and tile on the part of the university and Bureau of Public Roads.

A move to kill the publication of the *Proceedings* was balked and the whole matter referred to the publication committee with the consensus of opinion favorable to making some arrangement with the federation to publish in the *Bulletin* abstracts of the papers and proceedings, paying for the additional space required over that which would ordinarily be given to the state society.

The newly elected officers of the state society are: President, C. L. Mott; vice-president, T. H. Curtis; representative on the federation board, J. L. Pickles; secretary-treasurer, E. G. Briggs.

Engineering Societies

Calendar

Annual Meetings

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; Annual Convention, Chicago, March 13-15.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Norfolk, Va., May 7-9.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Spring Meeting, New Orleans, La., April 18-20.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Detroit, Mich., May 21-25.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 25-29 or 30.

The Boston Society of Civil Engineers on March 28 will hold its seventy-fifth annual meeing. In addition to reports of committees and election of officers there will be a smoker and vaudeville. The meeting is to be held at the Boston City Club.

The Society of Terminal Engineers, New York, will listen on Tuesday evening, March 13, to a talk on "Tentative Regulations of Marine Properties Against Damage by Fire," by Charles H. Fischer, chairman, committee on docks, piers and wharves of the National Fire Protection Association. The meeting will be held in the Engineering Societies Building, 29 W. 39th St. at 8 o'clock.

The Topeka Engineers' Club at its meeting recently elected as 1923 president F. W. Epps, bridge engineer of the Kansas highway commission, to succeed A. B. Griggs. R. H. Pennartz was elected first vice-president; W. S. Lammers, of the Santa Fe, second vice-president; H. E. Buchanan, of the public utilities commission, secretary and publicity director, and Clyde A. Funchess, of the Southwestern Bell Telephone Co., treasurer.

Personal Notes

COL. A. B. BARBER has been appointed manager of the department of transportation and communication of the Chamber of Commerce of the United States to succeed J. ROWLAND BIBBINS who has resigned to engage in private engineering practice. Colonel Barber is a graduate of West Point who served during the World War, first on the railway commission sent to France in the Spring of 1917 to study transportation conditions and later with the army in various capacities. After the war he was connected with the American Relief Administration in Central Europe and later became techical adviser to the Republic of Poland.

ALEX LARIVIERE, of Quebec, has been appointed by the provincial government of Quebec chief engineer of the Quebec Public Service Commission with offices at Montreal.

M. E. MILLIRON, of Butler, Pa., has been chosen city engineer of DuBois, a position recently made vacant by the resignation of WILSON MORROW. Mr. Milliron has been connected with the Carson Engineering & Construction Co. of Butler, Pa. He is a graduate of Ohio Northern University and has had eleven years' experience in railroad, highway and municipal engineering.

SULLIVAN W. JONES, of Yonkers, has been nominated by Governor Smith to be state archietct of New York, succeeding LEWIS S. PILCHER. Mr. Jones is a graduate of Massachusetts Institute of Technology and until recently had been technical director of the American Institute of Architects' committee on structural service.

GABRIEL HURTUBISE, consulting engineer and surveyor, has been authorized by the town council of Terrebonne, Quebec, to prepare a complete plan of the town, which was recently destroyed by fire.

F. W. SEIDENSTICKER, for more than 16 years engineer in charge of design in the Chicago office of Purdy & Henderson, and for the last five years chief engineer in the office of J. J. Heuser, engineer, Chicago, has opened a consulting office at 64 East Van Buren St., Chicago.

SOLOMON-ABBOTT CO., industrial engineers of New York, announce a change in the firm name to that of ABBOTT, MERKT & CO., INC. No change is made in the personnel of the firm except that Col. G. R. Solomon will be active only as a director and stockholder. Col. Solomon has become vice-president of the Earl & Wilson Co., collar and shirt manufacturers of Troy, N. Y.

E. H. MCGOVERN has been appointed office engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry. Co. with headquarters at Cincinnati, Ohio. He replaces F. H. PLAISTED, who recently resigned.

WILLIAM E. WILBUR, formerly designing engineer with Harrington, Howard & Ash, consulting engineers of Kansas City, Mo., has recently joined B. H. Klyce, consulting engineer of Nashville, Tenn. Mr. Wilbur is an associate engineer in the firm, in charge of bridges and other structures of steel and reinforced concrete.

G. E. FARNSWORTH, until recently a resident engineer with the Oregon State Highway Commission, has been made assistant engineer of the road department of the County of Riverside, Calif. He is stationed at Santa Monica.

E. H. WEILEMAN, former designer on hydro-electric developments with the Electric Bond & Share Co. of New York City, has become associated with Mees & Mees, consulting engineers of Charlotte, N. C., as designing engineer.

THE UNITED ENGINEERS, INC., 303 Wood Street, Pittsburgh, consulting engineers, has been recently incorporated by John M. Erhard, Lee L. Lamm, and others. The firm will specialize in structural and mechanical design and detail. John M. Erhard is president of the company.

MCCLELLAN & JUNKERSFELD, INC., announce that Renshaw Borie is associated with them in their work of engineering, construction, and management, and is in charge of their Philadelphia office at 112 South 16th St.

STEVENS AND WOOD, INC., New York City, announce that the engineering and constructing business formerly conducted by the Wood Hulse Yates Co. has been taken over and the personnel increased by associates of wide experience. The firm members of the new organization are R. P. Stevens and B. F. Wood.

DON L. JACOBSON has resigned as resident engineer of the Union Bridge Company of Kansas City at the Grand Town Power house terminal and has accepted a position as designing engineer for the Truscon Steel Company in their Kansas City office.

W. P. NEAR, who for the past ten years has been city engineer of Saint Catherines, Ontario, has resigned and has been appointed city engineer of London, Ontario.

H. Z. OSBORNE, JR., has resigned from the position of chief engineer, Board of Public Utilities, Los Angeles, Calif., which he has held for the past three years, to carry out the wishes of his father and become a candidate for United States Congressman from the Tenth District of California to succeed his father, who was the late Congressman Henry Z. Osborne.

RICHARD SACHSE has resigned as chief engineer of the California Railroad Commission, effective March 1, to engage in private consulting engineering work. Mr. Sachse entered the employment of the Railroad Commission in 1912 as assistant engineer and for the past seven years has been chief engineer.

Obituary

IRA C. SUNDERLAND, U. S. junior engineer of Detroit, Mich., died at Silver City, N. M., Feb. 15, aged 43 years. Mr. Sunderland's professional career began after his graduation from the University of Wisconsin in 1902, when he entered the service of the U. S. Lake Survey with headquarters in Detroit. From 1909 to 1919 he was in charge of the survey steamer, Col. J. L. Lusk, during which time he made topographic and hydrographic surveys along the West shore of Lake Huron. One of the most important surveys of which he was in charge was that of the so-called Nine-Fathom Bank, a rock reef in Lake Huron approximately fifty miles from the Michigan shore. His work formed the basis for a number of new and revised charts of various sections of the Great Lakes issued for navigators, by the U. S. Lake Survey Office. He was a member of the Detroit Engineering Society.

JOSEPH BENJAMIN RIDER, an engineer of South Norwalk, Conn. who maintained a consulting office in New York City, died at his home last week, aged 54 years. During recent years Mr. Rider had spent a great deal of time in consulting work for public and quasi-public works and utilities, paying particular attention to water supply and purification, sewerage and sewage and refuse disposal. He was a graduate of Rensselaer Polytechnic Institute, later receiving a doctor's degree from Lafayette. During his earlier professional career he had served as editor of *Fire and Water*, had contributed to the technical press, and was the author of "Rider's Little Engineer." He was a prominent member of the American Water Works Association and had been active in its proceedings. He was a member as well of the American Association of Engineers and the American Society of Mechanical Engineers.

WILLIAM MCNAB, of Montreal, late chairman of the valuation committee and engineer of the Grand Trunk Ry., died in Montreal, Feb. 23, aged 69 years. Mr. McNab was born at Irvine, Scotland, and entered the services of the Grand Trunk in 1870 as draftsman. He was appointed chief draftsman in 1887 and assistant engineer in 1896. He became principal assistant engineer in 1916 and chairman of the valuation committee in 1918. He was elected a director of the American Railway Engineering Association in 1905, and after holding the office of second vice-president, first vice-president and chairman of many committees, he was elected president of the association in 1908, being re-elected the following year.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Paint as an Aid in Maintaining Industrial Property and Equipment

Special Qualities Needed to Protect Metal Surfaces—Preparation of Surface Important—Spray Painting Has Many Advantages

UPKEEP painting, done at regular intervals, is one of the best investments a plant owner can make. This statement is made as a preface to a book of 190 pages by Roy C. Sheeler, soon to be issued by the Paint and Varnish Division of the E. I. Du Pont de Nemours & Co., Inc., Philadelphia, and intended as a practical aid to plant superintendents and others responsible for the maintenance of industrial property and equipment. From advance proofs of the chapters on painting and preservation of metal surfaces the following notes have been prepared:

If a protective coating can be applied that will keep out water in every form and if means could be devised to make the metal resistant to the flow of surface electric currents, there would be no corrosion. Iron will not corrode in air unless moisture is present and it will not corrode in water unless air is present. Paint manufacturers have developed finishes for metal surfaces which, if properly selected and used, will retard rust and decay.

ESSENTIAL QUALITIES

In general, a paint for the protection of iron and steel should be composed of suitable pigments combined with the proper vehicle, the resultant product being chemically permanent, chemically inert toward iron, resistant to physical damage, impervious to air and moisture, sufficiently elastic to expand and contract without damage, and rust inhibitive. The pigment must be exceedingly fine for satisfactory results and there must be an affinity between the pigment matter and the oil. If this attraction does not exist, the paint may brush out thin but be full of breaks and imperfections, giving poor protection to the metal underneath. Too rapid drying is an indication of unstable chemical condition. A paint that dries to a brittle, easily abraded surface is of little value on metal work.

Elasticity is one of the most important characteristics of a successful paint coating. If it does not expand and contract with the metal over which it is used it will quickly fail. Metal surfaces primed with a paint composed of a substantial amount of one or more basic or chromate pigments and finished with carbon or iron oxide paint, will be protected from corrosion under most conditions for a long time. Linseed oil, when used without the addition of pigment, is not a desirable material to use as a priming coat. Such a foundation coat is often a direct cause of peeling or blistering of the finishing coat. Paints containing tar or those with a tar base should not be used on steel structures exposed to the weather, as tar paint films rapidly check and crack.

PREPARATION OF SURFACE

The metal surface must be properly prepared before the paint is applied. It must be free from dust and dirt and all grease and oil should be removed by benzene. Rust and mill scale should be removed by sand blasting or with hammers, steel scrapers, or wire

brushes. Sand blasting is the best, but the most expensive method.

Galvanized iron surfaces, although able to withstand the action of the elements for a short time, should be painted promptly when new. In the process of galvanizing an oily surface remains, to which paint will not adhere. This oil must be removed by washing with a solution made by dissolving 8 oz. of copper acetate or copper sulphate in 1 gal. of warm water.

Application of Material

Faulty application is one of the greatest causes of paint defects. The use of the proper primer is of utmost importance. It should be brushed out well and not applied too heavily. Plenty of time between coats should be allowed for thorough drying. Paint will blister and peel if the surface on which it is applied is damp or if the coat applied is too heavy. The paint should be stirred thoroughly before using and the manufacturer's recommendations as to the material to use if thinning is required should be followed. If the contents of a paint container have skinned over, remove the skin—do not stir it into the paint under any circumstances.

In painting structural steel, the shop coat, which acts as a primer, is followed with a field coat. In each case the spreading capacity is about 750 sq.ft. per gallon, or about 2 tons of steel per gallon of paint, for one coat.

In painting steel tanks containing volatile liquids the color of the paint is vital. Dark colored paints absorb heat rays, causing loss by evaporation of the contents of the tank. Gloss finishes absorb less heat than flat paints.

Spray Painting

In spray painting just enough air pressure should be used to cause the paint to flow freely through the hose to the spraying machine. When working on the ground a pressure of from 5 to 10 lb. is sufficient to force the average material through the hose and from 35 to 45 lb. to atomize the paint at the nozzle. The nozzle should be held at a distance of from 6 to 8 in. from the surface to be coated. It is necessary to have a variety of sprays and nozzles for different kinds of work. The average spray requires 6 cu.ft. of air per minute. The spray job will generally prove more satisfactory for industrial upkeep purposes than brush work. Cleaning spray equipment after each day's work is of utmost importance. All paint should be blown out of the line and tank and half a gallon of kerosene run through. The spray should be disassembled from the hose and left in kerosene overnight.

In spray painting a large amount of scaffolding is eliminated and an operator can cover a surface 10 to 15 ft. distant. The average width of spray stroke is 10 in., as against 3 to 4 in. with a brush.

Periodic inspection of plant and equipment, at least once a year, should be made to determine the condition of all surfaces.

Paint for the specific purpose of construction equipment maintenance will be discussed in a supplementary article by Roy C. Sheeler, to appear in an early issue.—Editor.

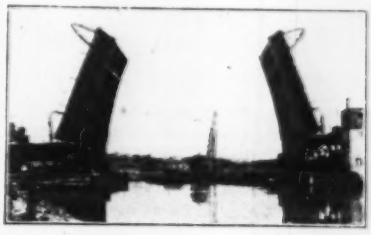
New Center Lock for Double Leaf Bascule Bridges

Jaw Castings and Links Act as Toggle in Closing Bridge—Wear Reduced by Improved Device

By P. L. Kaufman
The Strauss Bascule Bridge Co., Chicago

CENTER locks on double-leaf bascule bridges serve the function of equalizing the shear between the leaves where each leaf acts as a cantilever under live load. When one leaf is loaded and the other not—a condition that occurs every time a heavy wheel load passes the floor joint—it is apparent that unless some means is employed to cause both leaves to deflect practically the same amount there will exist an offset in the roadway at the joint.

Heretofore, the best center lock employed in bascule bridges consisted of a motor-driven latch-bar, or plunger, moving in guides secured to the bottom chord of each bascule truss, which fitted into a socket-like casting in the bottom chord of the other leaf.



First Bridge with New Lock
The State Street Bridge, Racine, Wis.

Bascule Bridge Center Lock in Open and Closed Positions

While the latch-bar type answers the purpose reasonably well, it has certain deficiencies. There is, for instance, considerable wear both in the guide castings and in the socket casting which can only be properly adjusted by a cumbersome method of shimming. In bringing the two bascule leaves to exact closure independently of the operating motors in the final stages of closing the bridge, the horizontal latch bar overstrains the connections of the guide and socket castings, besides creating friction and wear between the bar and the socket casting.

The so-called jaw lock developed and patented by the Strauss Bascule Bridge Co. overcomes the deficiencies above explained. It was installed for the first time on the State St. Bridge, Racine, Wis., completed in July, 1922. It will be seen from the illustrations that the lock consists primarily of two jaw-like castings attached to the end of each main girder of the leaf fitting securely into the rectangular mouth or opening of a flanged casting attached to the end of each main girder of the other leaf. The jaw castings are pivoted at their extremities and are moved back and forth by a pair of forged steel links. The links are, in turn, actuated by a crank pin on the hub of a gear wheel mounted in a collar bearing bolted to the girder web. The gear wheel meshes with a pinion keyed to a cross-shaft extending between the main girders and actuated at the center of the bridge by a 5-hp. electric motor.

The throw of the crank-pin is such as to cause the jaws to engage the opening in the flange casting. When the gear is revolved in the other direction the jaws are pulled back entirely clear of the casting. An adjustment is provided whereby the vertical distance between the horizontal faces of the jaw castings can be varied slightly until a proper fit is secured. The main castings are cast in half and bolted together in place which facilitated manufacture and erection.

The efficiency of the lock in drawing one leaf into place after the other is closed is apparent as the jaws and links act as a toggle and are a great assistance to the operator in finally closing the bridge. The advantage over the old style plunger lock in this respect is marked. The jaws, in disengaging, move away from the surfaces of the casting which they engage and thus avoid wear.

To Produce 3,000,000 Motor Vehicles This Year, Reeves Estimates

Based on figures for January and February, and depending somewhat on supplies of closed bodies, production of motor cars and trucks should approach the 3,000,000 mark in 1923, according to a statement made last week by Alfred Reeves, general manager, National Automobile Chamber of Commerce. The production for 1922 was 2,577,000 cars and trucks.

There are now 11,750,000 motor vehicles in use in this country, 10 per cent of which are trucks. Students of the industry, believe, Mr. Reeves said, that the United States can profitably use 12,000,000 cars and 3,000,000 trucks, which would require a renewal demand in excess of 2,400,000 vehicles.

To Develop Standards for Construction Equipment

The Associated General Contractors of America has requested the co-operation of the Materials Handling Division of the American Society of Mechanical Engineers in the development of specifications and standards for road-building and general construction machinery. The executive committee of the division, at its meeting Feb. 16, voted to co-operate with the contractors by undertaking, through its membership, the technical work involved. The contractors, it is understood, believe that there is an opportunity in the direction of simplification of repair parts and for improvement in the quality of materials entering into construction plant.

H. V. Coes, chairman of the Materials Handling Division of the A.S.M.E., presented a plan for organization within the society of a contractors' equipment code committee to produce the standard specifications discussed at the meeting. The plan involves co-operation of several of the professional divisions and the research and standardization committee of the American Society of Mechanical Engineers. It was pointed out that if the society, at the outset, communicated its plans to the American Engineering Standards Committee, the latter body would undoubtedly be glad to sponsor the work and would agree to have such specifications as were produced designated as American standards.

Business Notes

DAVID REEVES, president, Phoenix Iron Co. and Phoenix Bridge Co., Philadelphia, died Feb. 5.

DAVID COCHRANE, inventor, designer and first builder of the open feed-water heater which bears his name, died Jan. 24. He was born in Scotland in 1850, came to the United States in 1879 and while employed by the Harrison Safety Boiler Works, Philadelphia, brought out his open heater in 1883. His contribution to steam engineering made possible the more efficient utilization of exhaust steam for heating buildings and for heating and purifying water for boilers and other industrial purposes.

L. R. GRANNIS, former Chicago manager of the Blaw-Knox Co. and later manager for Landes & Co. of Denver, Colo., has been appointed as agent for the sales of Blaw-Knox products in Colorado. This selling representation by Mr. Grannis will cover road-building equipment, clamshell buckets, Prudential buildings and other products.

BRUCE C. WILSON, general manager of the Asphalt Block Pavement Co., Toledo, Ohio, will be connected with the Brooks Construction Co., Fort Wayne, Ind., as its secretary, after Feb. 1, 1923.

LOUIS W. SIPLEY has resigned from the position of Commercial Engineer in the Philadelphia office of the Safety Car Heating & Lighting Company, to become affiliated with the Alfred J. Forschner Co., Philadelphia, in the sale of construction equipment and contractors' supplies.

PENNSYLVANIA CRUSHER CO., Philadelphia, has opened a district office in Chicago in charge of C. S. Darling. The equipment handled will include single-roll crushers for primary breaking and hammer crushers for secondary and finer crushing of rock, in addition to coal-breaking machinery. Mr. Darling is a graduate of Worcester Polytechnic Institute, served as captain with the 108th Engineers during the World War and was editor of *Rock Products* during the past year.

J. A. FAY & EGAN CO., of Cincinnati, Ohio, manufacturers of wood working machinery, have leased the building at 260 Spear St., San Francisco and will occupy the structure as a salesroom and warehouse. The branch will be under the management of Guy D. Reynolds, Pacific Coast manager. Salesmen from this office will cover six western states.

P. H. BRIGHAM, formerly engineer with the New York State Highway Department, has resigned as engineer in charge of sales of road equipment in the Middle West for the Lakewood Engineering Co., Chicago, and has entered the firm of List & Gifford Construction Co., of Kansas City, Mo., in charge of its road construction, with headquarters at St. Louis, Mo.

E. O'KEEFE has discontinued his private engineering practice and will represent the Western Paving Brick Manufacturers Association in Iowa and Minnesota, with headquarters in Mason City, Iowa.

WAYNE WETHERILL, formerly chief engineer of the Link-Belt Co., Chicago, has opened an office in the Real Estate Trust Bldg., Philadelphia, as consulting engineer, specializing in conveying machinery and general construction.

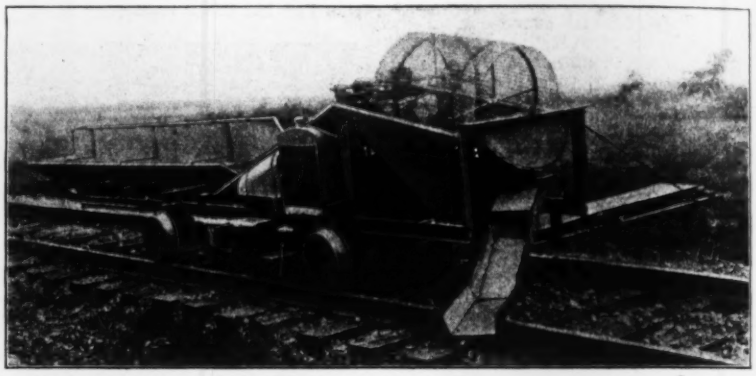
N. F. AMBURSEN has severed his connection with the Blaw-Know Co., Pittsburgh, where he held the position of chief engineer of the building department, and has entered into private consulting practice, specializing on hydraulic construction. Mr. Ambursen is the originator of the reinforced concrete type of dam which bears his name.

PENN METAL CO., Boston, has purchased the New England steel rod and bar business of the Midvale-Cambria Co., including all machinery, tools and merchandise. The Boston plant of the Midvale company will be operated by the Penn Metal Co. until such time as the Penn company's new bar and rod plant is completed. The list of steel shapes fabricated includes plain and deformed bars, plain rounds, rods, angles, cold-drawn steel, spirals for concrete columns. This gives the Penn company what is claimed to be the largest and most complete plant in New England for this kind of work.

Equipment and Materials

Ballast-Cleaning Machine on Santa Fe Ry.

For cleaning stone ballast in railway track a light power-operated and self-propelled machine introduced originally on the Atchison, Topeka & Santa Fe Ry. has been found more rapid and economical than the ordinary method of handling the material with ballast forks. The entire equipment is mounted on a low four-wheel truck and has an overall length of about 26 ft., with a weight of 1½ tons. One of the latest of the machines is shown in the accompanying view.



TRACK MACHINE FOR CLEANING RAILWAY BALLAST

Projecting beyond the front wheels is a long shallow hopper or trough into which the men shovel the dirty ballast. At the bottom of the trough is a 10-in. belt conveyor, 13 ft. long, feeding a similar conveyor inclined 22 deg. above the horizontal and fitted with leather slats or lugs. From this second conveyor the material is discharged into a cylindrical wire screen 34 in. in diameter and 44 in. long, having a rectangular mesh ¾ x 1¾ in. It revolves at 21 r.p.m. and in operation it is covered by a sheet-iron hood. Dirt falling through the screen drops into a hopper feeding a 16-in. belt conveyor carried by a lateral frame and discharging about 1 ft. beyond the toe of the ballast. Clean stone passing off the screen drops into a hopper with inclined delivery chute at the rear of the machine. This hopper and chute swing on a vertical axis, so that the stone can be delivered between or outside of the rails.

Power for the conveyors and screen and for propelling the car is furnished by a 15-hp. four-cylinder gasoline motor of the automobile type, the rear axle having a transmission gear with shaft driven from the motor shaft through a clutch. In going to and from work the machine can travel at about 13 m.p.h. By means of handles and a pair of flanged wheels set transversely to the

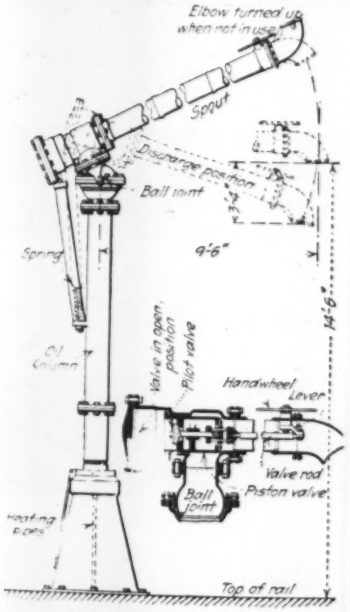
rails, the machine can readily be lifted, turned round and moved clear of the track on a pair of temporary rails at right angles to the track rails.

In operation, the machine is accompanied by a gang of about 18 men; 12 men digging out the ballast and shoveling it into the hopper, 1 man handling the stone chute, 1 man helping with the stone and also clearing away the dirt from the discharge conveyor when necessary, 2 flagmen, 1 machine operator and 1 foreman. The shoveling of ballast into the hopper averages 1 cu.yd. per man per hour. With ballast taken out to the bottom of tie at center of track and sloping to 4 in. below end of tie and then to the toe of the ballast, the quantity handled averages 30 cu.yd. per 100 ft. of single track.

This machine was invented originally by W. F. Muff, roadmaster of the Atchison Topeka & Santa Fe Ry., but has been developed and improved by the engineers of the Maintenance Equipment Co., Chicago, which is now manufacturing it.

New Detail for Oil Columns in Railway Service

A reversible discharge elbow on the spout of an oil column for supplying oil fuel to locomotive tenders is a new device introduced by the T. W. Snow Construction Co., Chicago, to prevent the waste and nuisance of oil dripping on the track. For delivering oil, the pivoted spout is pulled down to the position indicated by the dotted line in the

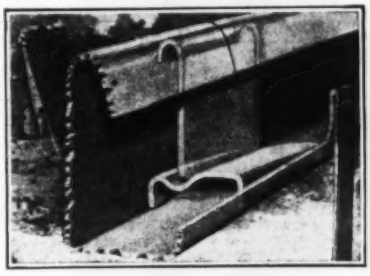


accompanying drawing. When the tank is full the fireman reverses the position of the elbow and releases the spout, which is returned to a position above the horizontal by means of a coiled spring. In this position oil in both the elbow and spout is drained back to the valve chamber at the rear of the spout. A full opening for the flow of oil is given by a piston valve having its stem within the spout and operated by a lever and hand wheel. The first movement of the valve rod opens a small pilot valve to equalize the pressure and further movement of the rod then opens the main valve.

Road Form Has Line-Point Top and Rivetless Wedge Joints

Elimination of all rivets, bolt holes and stake boxes, a rounded or line point top surface on which stone or concrete cannot lodge and interfere with the smooth riding of finishing machine, subgrader, or hand templet, and a lock joint of two simple wedges, are distinctive features of the Carr form for concrete roads which has recently been introduced by the Lakewood Engineering Co., Cleveland, Ohio. The several points in which the design of this form differs from that of other road forms are indicated in the accompanying sketch.

The form is manufactured of $\frac{3}{16}$-in. metal in 12-ft. lengths, 20 per cent



longer than has been customary for road forms, thus reducing the number of joints. The rounded top, the manufacturer claims, provides a self-cleaning feature inasmuch as it prevents concrete or pieces of stone resting on the top surface and causing bumps over which the wheels of the finishing machine must pass. With the line point top, therefore, an accurate thickness and smooth surface of concrete slab is secured. Even a slight tilting of the form, it is pointed out, does not change the elevation of the top surface or working edge.

An ingenious locking arrangement of two simple wedges insures accurate and rigid connection of form sections. The wedges are tightened or loosened by a few blows of a hammer or, if that tool is not handy, the metal stake itself may be used.

The base of the forms is 5 in. wide, sufficient to afford ample bearing for the support of mechanical finishing and subgrading machines. The usual stake boxes are done away with and a flat stake with a penetration of 18 in. may be driven at any point to engage the upturned outer edge of the form base. As a rule, three stakes are used for each 12-ft. section of form.

The forms are manufactured in heights of 6, 7, 8, and 9 in., weighing, without wedges and stakes, 9, 9.6, 10.2, and 11 lb. per foot, respectively. The simplicity of the design of this form minimizes handling costs on the job, in addition to producing a smooth slab of accurate thickness.

SAMUEL M. VAUCLAIN, president, Baldwin Locomotive Works, has accepted an invitation from Dr. Thomas S. Baker, president of Carnegie Institute of Technology, to address the general assembly of students March 14. For many years Mr. Vauclain was superintendent of the Baldwin works, becoming vice-president in 1911, senior vice president in 1917, and president in May, 1919.

Publications from the Construction Industry

Industrial Railway Equipment — KOPPEL INDUSTRIAL CAR & EQUIPMENT CO., Koppel, Pa., illustrates and describes its line of narrow-gage cars, tracks, and batch boxes in a new bulletin. One of the newer developments is the multiple batch-box truck, designed for 24-in. gage track and with a capacity of 20,000 lb. or five loaded 31-cu.ft. batch boxes. The same type of truck for 36-in. gage has a capacity of 36,000 lb., or five loaded 54-cu.ft. batch boxes. Both steel and wood batch boxes are illustrated; they are of the tip-over and the drop-bottom types. With the latter a special cement compartment may be used.

Water-Works Pumps — DE LAVAL STEAM TURBINE CO., Trenton, N. J., in a 100-p. illustrated manual, entitled "Ten Years' Progress in Water-Works Pumps," presents to water-works officials and engineers not merely an outline of the development of the steam turbine driven centrifugal pump, but a comprehensive technical treatise with photographs and diagrams on steam pumping units. In addition, there are detailed descriptions of actual installations in many of the principal cities of the country. The manual is replete with engineering data. There is a chapter on water measurement with Venturi meter, orifices and nozzles and Pitot tubes. A considerable amount of tabulated matter is presented as well as curves and charts for determining resistance of pipes to flow of water.

Lighting Data—EDISON LAMP WORKS, of the General Electric Co., Harrison, N. J., has issued a series of illustrated bulletins dealing with the lighting of industrial plants of all kinds. Specific data are given for textile mills, woodworking plants, paper and pulp mills, garages, the food industries, and street lighting with Mazda lamps.

Water Testing Apparatus—WALLACE & TIERNAN CO., INC., Newark, N. J., is issuing a series of technical publications describing its various bacteriological and chemical testing outfits for water supply and sewage treatment work.

Paving Mixers—Chain Belt Co., Milwaukee, has just issued a new 44-p. catalog, covering the 1923 models of Rex pavers. It is well illustrated and many of the operating features are shown with the internal mechanisms exposed to indicate their exact functions. The machines are shown with both full and half length chain treads. Particular attention has been given to the enclosed transmissions. The discharge of the Rex pavers has been speeded up by the use of an enclosed automatically controlled mechanism which relieves the operator the moment the discharge chute is placed in motion. On the charging skip the throat opening has been designed so that neither the throat nor drum openings are restricted by the discharging angle of the skip. The distributing system has several automatic operating features.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Production and Materials Stocks In Nine Cities

Steel Operations at 90 Per Cent of Capacity—Lumber Output Recovering—Winter Brick Production at High Mark

Steel—With the pig-iron output more active than at any time during the last two years, the average yearly production rate for steel ingots, promises to run well above 45,000,000 tons for the current month. An average annual rate of 40,000,000 tons prevailed during the last quarter of 1922, with an increase of 10 per cent in the first month of the new year. The steel industry is now reported to be operating at 90 per cent of capacity as against 55 per cent, one year ago. Increasing operations, however, face decreases in the labor supply, as, beginning with the current month, out-door labor is expected to attract many men away from the steel mills.

Lumber—Total production for the entire country, as reported to the National Lumber Manufacturers' Association, reached 785,022,079 ft. b.m. for the month ending Feb. 24. In comparing this total with 766,498,788 ft. cut during the month ending Jan. 27, a strong recovery is shown during the last week in February from the temporary restrictions imposed by the severe weather of the middle of the month. February shipments reached 980,852,638 ft. as against 951,036,199 ft. during January. There was a slight let up in demand, however, as shown by February orders for 1,042,652,940 ft. as compared with 1,093,505,601 ft. during January.

Cement—Although the trend of mill shipments, which had been downward during October and November, took a sharp upward turn in December and continued in that direction during January, mill stocks have been steadily accumulating since October owing to the seasonal slackening of demand. The production curve in the meantime, pointed downward from October to January. With prospects of an unprecedented demand close at hand, production is expected to take a sharp upward turn followed closely by shipments, and with a gradual lessening of reserve stocks at factories from April to October of the current year.

Brick—Although nearly one-third of the brick plants of the country shut down, largely for seasonal reasons, the winter production is at the highest mark in recent years, according to the Common Brick Manufacturers' Association of America. Total burned brick on hand as of Feb. 1, amounted to 199,449,000, against 238,858,000 available Dec. 1, 1922.

San Francisco—Fairly well supplied with lump lime, expanded metal lath and hollow tile. Shortage of cement, structural rivets and wire nails. All other building materials plentiful.

Denver—Plenty of brick. Stocks of nearly all construction materials at normal levels.

Minneapolis—Shortage of face brick.

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (Lumber, Minneapolis, 100,000,000 ft.); time required for delivery of carload lots to city job, example: (hollow tile, Atlanta 5 @ 7 days); and stocks on hand in general terms, example: (sewer pipe, Philadelphia, depleted.)

	San Francisco	Denver	Minneapolis	Detroit	New Orleans	Atlanta	Baltimore	New York	Philadelphia
Sewer pipe	Plenty	Del. 24 hr., local plant	Sufficient	Plenty; demand increasing	Fairly well supplied	Del. take 5 @ 7 days	Enough	Mill del. slow	Depleted
Cement	Small reserve	Normal	Large Quantities	Sufficient for immediate demands	Plentiful	30 @ 40 cars	Shortage	No Shortage	Stocks low
Lime	Fair Supply	Plenty	Ample	Enough in warehouses; del. prompt	Enough	25 cars	Ample	Enough at present; demand increasing	Limited supply
Common brick	Large quantities on hand	3,000,000	Available at short notice	Moderate supply in local yards	Large supplies	Plenty	Shortage; demand heavy	50 @ 60 bargeloads	Yards working to capacity
Hollow tile	Fairly well supplied	Stocks normal	Sufficient	Small stocks; del. take several days	About enough	Del. take 4 @ 5 days	Sufficient	Nearby plants; del. by water	Enough and no excess
Lumber	Heavy stocks	Normal level maintained	100,000,000 ft.	Normal; filling all demands	Mils filling all orders received	Plenty	Well stocked	Del. take 4 @ 6 weeks from mill	Shipments heavier than replenishments
Asphalt	Extensive native reserves	About 10 cars	Enough	Del. take one to two days	No market	Well supplied	Enough	Heavy reserves in N. J.	Supply center none moving
Structural steel	Plenty of structurals; low on rivets	Warehouse stocks sufficient	Meeting all demands	Enough in warehouses	Sufficient for present	About 5 cars	Plenty in warehouses	Mill shipments slow	Premiums on quick mill del.

REPORT ON COMMON BRICK FROM 90 YARDS AS OF FEBRUARY 1, 1923

Dist. No.	Including States Of	No. of firms reporting	Plants closed down	Burned Brick On Hand	Unburned Brick On Hand	Orders On Books	Price Per Thousand At Brickyard
1.	N. Y., New England	7	5	9,847,000	4,300,000	14,765,000	$15.00 to $20.00
2.	Pa., N.J., Md., D.C., Del.	11	5	21,151,000	4,873,000	43,142,000	14.00 to 20.00
3.	Va., N.C., S.C., Ga., Fla.	7	1	4,619,000	1,284,000	1,645,000	12.00 to 16.00
4.	Mich., Ohio, W. Va.	5	2	4,867,000	220,000	5,980,000	13.50 to 15.50
5.	Ill., Ind., Wis.	25	3	138,609,000	5,213,000	156,786,000	10.00 to 16.00
6.	Ky., Tenn., Miss., Ala., Ark., La.	12	5	4,740,000	3,815,000	10,560,000	10.00 to 20.00
7.	N. & S. Dak., Minn., Neb., Ia., Kan., Mo.	6	5	3,442,000	40,000	1,170,000	10.25 to 18.00
8.	Okla., Tex., N. M.	3	1	3,606,000	56,000	563,000	8.00 to 12.00
9.	Wash., Ore., Mont., Wyo., Ida., Utah, Colo.	10	3	6,139,000	2,881,000	1,545,000	12.00 to 16.00
10.	Calif., Ariz., Nev.	4	2	2,429,000	2,644,000	2,330,000	14.50 to 15.50
		90	32	199,449,000	25,326,000	238,486,000	

Lumber supply unchanged during month, with plenty on hand. Dealers looking forward to early spring demand.

Detroit—Small stocks of hollow tile; delivery in large quantities requiring several days. Sufficient cement to supply immediate demands. Some mills so heavily booked ahead that even large orders are being declined. Asphalt available in one to two days. Plenty of all other materials.

New Orleans—No market for asphalt and crushed stone. Building materials plentiful with heavy demand. Lumber mills filling all orders received; railroads buying in large quantities.

Atlanta—Plenty of lumber, asphalt and common brick. About thirty to forty carloads of cement; twenty-five, of lime and five cars of structural steel, on sidings. Hollow tile deliveries take four to five days; sewer pipe, five to seven.

Baltimore—Shortage of cement; none in the market. Scarcity of common brick; demand heavy.

New York—Pine lumber shipments from mill, received in four to six weeks as against six to eight weeks, one month ago. Enough lime at present but unusually heavy demand anticipated before end of current month. Slow pipe deliveries from mills. Between fifty and sixty bargeloads of common brick

(Concluded on p. 472)

Trend of Production, Sales, Prices and Wages Upward

Business Conditions as Reviewed by the Federal Reserve Agent at New York Show General Improvement

Further increase in the volume of production in basic industries to a level higher than in 1919 or 1920, a continued advance in the prices of many basic commodities, additional borrowing from banks for commercial purposes, and somewhat higher money rates are the principal recent developments in the business situation, according to the *Monthly Review* of the Second Federal Reserve District.

Production in basic industries, as measured by the Federal Reserve Board's index, was 6 per cent higher in January than in December, and reached a volume exceeded only once in the past, in May, 1917. Production of steel ingots and of anthracite coal and mill consumption of cotton showed particularly large advances, and most other important industries increased their output. Building operations have been maintained on a large scale.

EMPLOYMENT AND WAGES INCREASED

Industrial employment continued to increase during January, and shortages of both skilled and unskilled labor were reported by textile mills, steel mills, and anthracite coal mines. More wage increases at industrial establishments were announced than in December. There is still some unemployment in States west of the Mississippi. In industrial and commercial centers there has recently been a larger demand for office workers, although throughout the country there is much unemployment in this group.

The index number of the Bureau of Labor Statistics, computed from the wholesale prices of about 400 commodities, including finished and semi-finished products as well as raw materials, showed the same average level of prices in January as in November and December. Between December and January the prices of clothing, fuel, metals, building materials, chemicals and house furnishings advanced, but these advances were accompanied by declines in farm products and food, so that the combined index remained unchanged. During recent weeks the prices of a number of basic commodities advanced rapidly and in many cases reached the highest points since 1920 or the early part of 1921.

An active distribution of goods for this season of the year is indicated by reports to the Reserve Banks, both of wholesale and retail dealers for the month of January. Sales of department stores in over 100 cities were 12 per cent larger than in January, 1922. Inventories show that there has been no large increase in stocks of goods held by department stores and the rate of turnover continues rapid.

Money rates showed a tendency to become firmer, especially in recent weeks. The open market rate for commercial paper, which was 4 per cent last summer, rose during February from a range of 4¼-4½ to a range of 4¾-5 per cent.

On Feb. 23 the discount rate on all classes of paper at the Boston and New York Reserve Banks was advanced from 4 to 4½ per cent.

The changes in principal aspects of industry and trade are summarized below. Comparisons are made between those months when low points were reached and the month of January.

Industry—Production, measured by the index of output in 22 basic industries, has increased since July, 1921, 54 per cent. Employment, measured by the number of workers employed in New York State factories, has increased since July, 1921, 23 per cent.

Trade—Wholesale trade in this district, measured by the sales reported by representative dealers in 10 lines (with allowance made for seasonal changes), has increased since July, 1921, 31 per cent. Retail sales in this district, measured by the reports from 60 department stores (with allowance for seasonal changes), has increased since September, 1921, 13 per cent.

DEBITS TO INDIVIDUAL ACCOUNTS HIGHER

Bank Transactions in 140 centers outside New York City, measured by debits to individual accounts (with allowance for seasonal changes), have increased since July, 1921, 32 per cent.

Prices—This bank's index of wholesale prices of 20 basic commodities increased from June, 1921, to February, 24, 1923, 30 per cent. The Department of Labor Index of wholesale prices increased from January, 1922, to January, 1923, 13 per cent. The cost of living, measured by the index of the National Industrial Conference Board, increased from June, 1922, to January 15, 1923, 2 per cent.

Wages—The hiring rate of wages for unskilled labor in this district increased from April, 1922, to January 15, 1923, 16 per cent. Average weekly earnings of workers in New York State factories increased from April, 1922, to January 15, 1923, 9 per cent.

The differences between these various percentages of increase may be largely accounted for by the relation which the items measured bear to the immediate processes of consumption. In general, the nearer an item stands to immediate consumption the smaller will be the change which it shows in periods of business change. The consumption of goods goes forward with relatively little regard to the changes in business conditions, whereas processes far removed from the ultimate consumer, such as the production of basic commodities, are likely to move more widely and in close relation to the changes in business conditions.

State Road Programs

Kentucky appropriations thus far amount to $7,701,157.79. It is probable that additional appropriations to the amount of $2,500,000 will be made during the year.

Mississippi expects to let contracts this year for 50 miles of hard-surfaced roads estimated to cost $1,750,000 and 300 miles of graded and gravel-surfaced roads to cost $4,250,000.

Florida road funds for 1923 amount to about $3,000,000, of which $500,000 is allowed for maintenance, the rest for new construction.

Texas road work is not limited by the seasons, and contracts are being let and new work is being started every month. There are now 19,000 miles under construction at a total estimated cost of $26,415,000.

Arizona's legislature has not yet made appropriation for 1913.

California has not yet outlined its road program.

Oregon has not worked out a detailed program for 1923, but expenditures for the year will aggregate not less than $10,000,000. The work will involve the construction of 60 miles of pavement, 300 miles of broken stone and gravel surfacing, and 300 miles of grading.

Colorado's estimated disbursements amount to $9,236,350, of which $5,272,700 is for Federal Aid projects, the remainder for State and County. Some of the items are: Maintenance, $825,000; property and equipment, $150,000; administration, $281,454.

Minnesota's Legislature has received recommendations for highway bond issues of $10,000,000 each for 1923 and 1924. These proposals may not be acted upon until Apr. 20. Exclusive of bond issues about $6,500,000 is available for state highway work in 1923; while counties, townships and city villages will raise about $19,000,000 for roads.

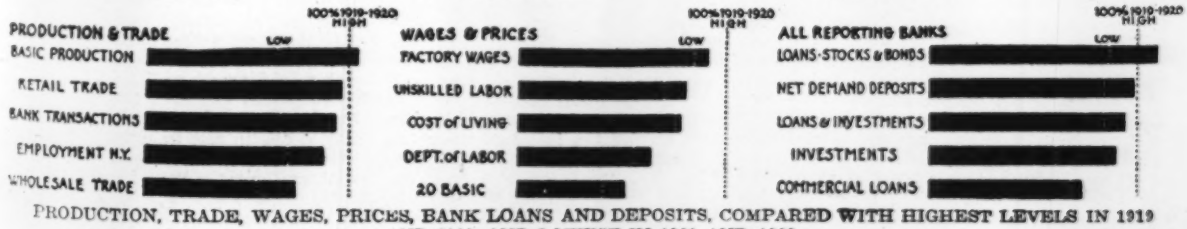
Iowa has now before the Legislature proposals which may greatly affect the 1923 road program. Without additional legislation there is a paving program of 100 miles; a gravel surfacing program of 400@500 miles, and a grading, draining and bridging program of 1,000 miles. This work is on the primary road system. In addition there will be work on the secondary road system, which cannot be estimated at present.

Nebraska appropriations have not yet been made. The road program will probably be available by April 1.

Kansas appropriations have not yet been made. The State Highway Engineer writes: "Our work is handled entirely from Federal Aid funds, which are maintained by the counties. The county funds are raised mostly from Benefit Districts which come up from time to time as work is desired."

Arkansas expects to spend $10,000,000 on improved highways this year.

Washington appropriations will soon be announced.



PRODUCTION, TRADE, WAGES, PRICES, BANK LOANS AND DEPOSITS, COMPARED WITH HIGHEST LEVELS IN 1919 AND 1920, AND LOWEST IN 1921 AND 1922

Nevada has $2,500,000 available for construction, and the following projects will be placed under contract this year:

	Miles
Grading and gravel	163.50
Concrete	4.24
Overhead crossing	.75
Asphalt macadam	2.10
Asphalt or gravel surface	10.00
Gravel surface	12.00
Total	192.59

Utah plans to construct 170.398 miles of highways in 1923, as follows: 19.23 miles of graded earth; 133.068 miles of graveled surface; 11.53 miles of concrete; 5 miles either concrete or bituminous; 1.57 miles of road to eliminate grade crossings. This work is estimated to cost $2,056,865.86, of which $1,032,158.61 is for completing projects now under construction, and $1,023,717.25 for new work. The source of these funds: approximately 74 per cent from Federal Aid, and the remaining 26 per cent from county funds.

(*Concluded from p. 470*)

at docks, but nearly all sold. Fewer reserve brick now in Hudson River district than one year ago; river still blocked by ice.

Philadelphia—Lime, cement, common brick and sewer pipe stocks depleted. Brick yards operating to capacity to meet present demand. Mill shipments of sewer pipe slow. Lumber, all grades, being shipped from local yards faster than replenished. Enough hollow tile but no excess.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of March 1; the next, on April 5.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb	+$3.44	$3.95	$4.40	$3.05	+$3.45	$3.95	+$3.45	$3.80	$3.75
Structural rivets, 100 lb	+4.00	4.60	5.25	3.75	4.00	4.95	4.75	4.25	5.50
Reinforcing bars, ¾ in. up, 100 lb	+3.34	3.85	3.15	+3.07½	+3.35	3.62½	3.30	3.80	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	51%	53%	45%	59½%	55-5%	38%	38.2@46.5%	45%	32.76
Cast-iron pipe, 6 in. and over, ton	56.50	51.00	57.00	53.20	58.50	65.00	57.00	+58.00	55.00
Concreting Material:									
Cement without bags, bbl	+2.70@2.80	2.75	2.25	2.20	2.39	2.85	2.71	2.90	2.88
Gravel, ¾ in., cu.yd	2.00	1.75	2.25	2.25	1.75	1.90	2.15	1.00	1.50
Sand, cu.yd	1.00	1.24	1.87½	2.25	1.00	1.00	1.50	1.00	1.25
Crushed stone, ¾ in., cu.yd	1.75	2.00	2.00	2.25	2.25	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	63.00	37.00	53.00	+60.50	43.75	—51.00	—39.00	29.00	95.00
Lime, finishing, hydrated, ton	16.80@17.10	23.00	22.50	+20.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl	3.00@3.25	1.85	2.50	+1.50	1.25	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000	23.50	12.00	11.00	11.00	17@19	12.00	15.50	13.00	+16.50
Hollow building tile, 4x12x12, per block	Not used	.0859	.115	....	.0836	.065	....	.11	.115
Hollow partition tile 4x12x12, per block	+.1314	.0859	.115	.0674	....	.065	.108	.11	....
Linseed oil, raw, 5 bbl. lots, gal	+1.01	+1.12	+1.16	+1.07	+1.13	1.21	1.09	.86	1.02
Common Labor:									
Common labor, union, hour	.60	.35	.30@.50	.....	.....	.50@.55	.56¼	....	.....
Common labor, non-union, hour	.45@.60	.30	.30@.50	.72½	.35@.50	.35@.50	.50	.30@.70	.25

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Cement and concrete laborers' rate, 81½c.; pick and shovel men, 60c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine casing. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 98.25). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $32.76; 6-in., $108.

Changes Since Last Week

Steel structurals advanced 10c. in San Francisco and 15c. per 100 lb. in New York and Minneapolis warehouses, during week. The warehouse rise naturally followed a gradual upward trend in mill quotations, which in turn were affected by increased demand and higher costs of labor and raw materials. Trend of pig-iron prices higher due to wage increases in Southern ore and coal mines. New inquiries having stimulated mill prices to the current range of $2.25@$2.40, the minimum of $2.20 per 100 lb. has disappeared from the market. Some makers place a minimum of $2.25 per 100 lb. on plates and shapes, others, $2.35; as high as $2.50 having been quoted as a maximum. Structural buying is mostly in small lots at present, but with a constantly increasing volume of inquiries. Plate mills are overbooked, especially on car materials; quick deliveries being impossible with present heavy demand and limited transportation facilities.

The price of cement, per bbl., has advanced during the last two weeks at the following mill points: Buffington, Ind., 15c.; Universal, Pa., and Steelton, Minn., 10c.; Mitchell, Ind., Mason City, Ia., and LaSalle, Ill., 5c. New York warehouses quote cement at $2.70@$2.80 per bbl. without bags, for immediate delivery, as against $2.60@$2.70 one week ago.

Lumber market firm, railroad material and structural timbers continue to be the most active in demand. Long leaf yellow pine timbers, base sizes, quoted in Chicago at $60.50 as against $56.50 per M ft., b.m., two weeks ago. Douglas fir lumber tending upward in Seattle due to rise in price of logs.

Continued upward trend in prices of paint materials. Raw linseed oil rose 2c. in New York; 4c. in Minneapolis; 5c. in Chicago; 6c. in Dallas and 10c. per gal. in Atlanta, during week.